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Hepaticae of Puerto Rico

V. CERATOLEJEUNEA

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(WITH PLATES 19 AND 20)

Ceratolejeunea is one of the most natural genera of the Lejeuneae, and its distinctive characters were appreciated long before it was formally recognized as a genus. Apparently the West Indian *C. cornuta* (Lindenb.) Schiffn. * is the species which first appears in the literature. This was originally described as a *Jungermannia* † but a few years afterwards was referred to the genus *Lejeunea* by Nees von Esenbeck.‡ Meanwhile Dumortier had placed it in his newly proposed genus *Colura*, § of which the type species was *Jungermannia calyptrifolia* Hook. The two species are totally distinct in their vegetative structure, having little in common except their horned perianths, and even in these there are structural differences of importance. In spite of these facts, they are still kept together in the Synopsis Hepaticarum under the section *Ceratanthae* of the genus *Lejeunea*.‖ The authors, however, divide this section into two subgroups, *Genuinae* and *Aberrantes*. The first of these corresponds exactly with the genus *Ceratolejeunea*, as now understood by most writers, and includes *C. cornuta* and about fifteen of its immediate allies. The second is a much more artificial group

* Bot. Jahrb. **23**: 583. 1897.

† Lindenberg, Nova Acta Acad. Caes. Leop.-Carol. **14**, suppl.: 23. 1829.

‡ Naturg. der europ. Leberm. **3**: 265. 1838.

§ Recueil d'Obs. sur les Jung. **12**. 1835.

‖ *L. c.* 399. 1845.

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and includes species belonging to the two modern genera *Colurolejeunea* and *Leptolejeunea*. Many years later Trevisan * revived Dumortier's genus *Colura*, giving it the same limits as the section *Ceratanthae* of the Synopsis. The subsequent history of *Ceratolejeunea* is the same as that of other genera of the Lejeuneae; it was first described as a subgenus by Spruce † and afterwards elevated to generic rank by Schiffner.‡

Ceratolejeunea is composed entirely of tropical and subtropical species and attains its highest development in the mountainous forests of America. A few species, however, are known from paleotropic regions and from the islands of the Pacific. The plants usually grow on rotten logs or on the bark of trees or shrubs but sometimes occur on shaded rocks or even on living leaves. As a rule, a given species is more or less particular in its choice of a substratum. In some cases the plants grow mixed with other hepatics but it is much more usual to find them in pure mats, which sometimes measure several feet in length. The stems are at first prostrate and cling closely to the substratum, but in old mats the plants become depressed-cespitose and often stratified in appearance and the branches assume a more or less parallel position.

Although classed among the Lejeuneae Schizostipae, the species of *Ceratolejeunea* are more robust than is usual in this group and are further distinguished by their olive-brown color and by their glossiness. The color is due to a pigmentation of the cell-walls and is sometimes pronounced enough to make the plants appear almost black; under other circumstances it is hardly sufficient to mask the green color of the chloroplasts. In their general appearance the plants bear a strong resemblance to certain genera of the Holostipae, such as *Lopholejeunea* and *Odontolejeunea*.

The leaves are imbricated, although rarely densely so, and the lobe is broad and falcate, spreading widely from the axis. In the majority of cases the lobe is convex and the apex more or less reflexed. The antical margin is rounded except in the basal region, but the postical margin is more variable, being sometimes slightly rounded, sometimes nearly straight and sometimes distinctly

* Mem. r. Ist. Lomb. III. 4: 401. 1877.

† Hep. Amaz. et And. 198. 1884.

‡ Engler & Prantl, Nat. Pflanzenfam. 1³: 125. 1893.

incurved. The apex is usually broad and blunt but is frequently abruptly apiculate or acute. In some cases the margin of the lobe is entire throughout or indistinctly crenulate from projecting cells, in other cases it is more or less toothed, especially in the apical region, and in a few species it is sharply spinose. The leaves are exceedingly variable in certain species, and the degree of marginal dentation must always be used with caution as a diagnostic character.

Except near the base of the lobe, the leaf-cells are more or less convex, and their walls are strongly thickened throughout. The middle lamella appears as a fine but distinct line and is clearly visible without the use of reagents (PLATE 19, FIGURES 5, 15). The thickening is deposited upon this lamella in the form of a layer and is practically uniform over both horizontal and vertical walls except for the scattered pits connecting the cells (FIGURES 6, 16). Viewed from the surface of the lobe, the thickenings appear in the form of large and often confluent trigones with occasional intermediate thickenings. The degree of thickening often varies in a single species, and is apparently dependent upon external conditions. Ocelli can frequently be demonstrated; they differ from ordinary cells in their larger size, in their thin walls and in their more oily contents (PLATE 20, FIGURE 7). In the majority of the species they occur singly or in small irregular groups near the base of the lobe, but in at least one species they form a short row simulating a nerve. In certain species, the number and even the occurrence of ocelli is subject to variation, some of the leaves failing to develop them altogether.

The lobule when normally developed conforms very closely to that described for *Prionolejeunea* and for certain other genera of the Lejeuneae, the hyaline papilla being proximal in position and the apical tooth short and curved (PLATE 19, FIGURE 18; PLATE 20, FIGURES 10, 11, 24). The free margin of the lobule is involute to beyond the apex and appressed to the lobe, the apical tooth and the sinus helping to form the opening into the water-sac. The lobule is inflated throughout and is more or less curved in the outer part (PLATE 19, FIGURES 12, 13; PLATE 20, FIGURES 1, 3, 19).

The type of lobule just described is, however, subject to

two modifications, both of which tend to increase the size of the water-sac. In the first the keel is so strongly arched that it is approximately semicircular in outline (PLATE 19, FIGURE 2). At the same time the free portion of the lobule, which is involute throughout its entire length and appressed by its surface to the lobe, shows a distinct fold of involution almost as strongly arched as the keel itself. The result is that the water-sac becomes almost spherical in shape and exhibits a very minute opening. The free margin of such a lobule is rounded and the apical tooth shorter than usual and nearly straight (FIGURE 9); the hyaline papilla maintains its usual position and appearance. With this first modification of the lobule, the lobe is sometimes as large as in ordinary leaves, but is often considerably reduced in size.

In the second modification of the lobule the peculiarities of the first are exaggerated, and the water-sac is several times larger than in normal leaves. Enlarged water-sacs of this type are described as "utriculi" and occur singly or in a pair at the base of a branch (PLATE 19, FIGURES 1, 4, 12, 14; PLATE 20, FIGURE 4). The keel is here so strongly arched that it forms rather more than a semicircle and is quite a little longer than the free margin. The free portion of the lobule is in the form of a small lamina, which varies in shape from rectangular to trapezoidal and is usually cut off square at the end. This lamina is revolute and concealed within the water-sac. Sometimes it is slightly concave and helps to form an oval opening into the sac; sometimes it is strongly concave and the opening becomes more nearly circular. The apex and the hyaline papilla are essentially the same as in the second modification. The free portion of the lobe is very greatly reduced in size.

Certain species constantly develop the normal type of lobule or produce the spherical modification only in exceptional cases; others show a preference for the spherical form but sometimes revert to the normal; still others exhibit both normal and spherical lobules in almost equal number. In certain species the utriculi are apparently never developed; in others they occur with greater or less frequency. In all probability the development of both spherical lobules and utriculi is dependent upon external conditions, but at the present time no definite statements to this

effect can be made. Of course, under some circumstances the lobules fail to develop or present a very rudimentary appearance.

The underleaves are attached by an almost straight line of insertion and often show a rudimentary disc in the basal region, from which the rhizoids develop. They vary in shape from orbicular to broadly reniform, and the base varies from cuneate to deeply cordate. In the majority of the species the underleaves are bifid; in a very few species they are undivided. The margin is commonly entire.

The inflorescence in the genus seems to be almost equally divided between autoicous and dioicous. The archegonial branch varies greatly in length in most of the species, but is invariably subtended by one or two innovations, which are themselves often floriferous. The bracts are usually connate with the bracteole and sometimes with each other (PLATE 20, FIGURE 17). They are rarely much larger than the leaves and are often perceptibly smaller.

The perianth is perhaps the most striking feature of the genus. It is more or less obovoid in shape and abruptly narrowed into a short but distinct beak. In the lower part it is nearly terete; in the upper part the antical surface is plane or nearly so, but there are two distinct lateral keels and two postical keels. Each of these four keels grows out beyond the beak in the form of a hollow horn, which sometimes remains short and sometimes becomes nearly as long as the remainder of the perianth (PLATE 19, FIGURES 1, 12; PLATE 20, FIGURES 1, 2, 21). Such a horn is formed by the rapid growth and division of the cells in the upper part of the keel and shows at maturity a group of small and thin-walled cells at its apex, very different from the thick-walled cells found elsewhere in the perianth. On account of the delicacy of these cells, the horns often become irregularly torn at the apex but it is doubtful if they are ever normally toothed or spinose. In rare instances a fifth horn grows out from the base of one of the other horns and is supplementary to it. Of course, a five-horned perianth of this type is very different from that found in such a genus as *Leptolejeunea*, where the fifth horn is always antical in position.

Specialized organs of vegetative reproduction have not yet been observed in *Ceratolejeunea*. It is not unusual, however, for a

leaf-cell to give rise directly to a leafy shoot or propagulum without the interpolation of a protonemal structure. This takes place more readily in a leaf which has become detached but sometimes occurs in an intact leaf. Propagula of this type are homologous with those described for *Plagiochila*.

Five species of *Ceratolejeunea* have been recorded from Puerto Rico. Three of these are mentioned in Hampe and Gottsche's list of Schwanecke's hepatics; namely, *L. ceratantha*, *L. patentissima* and *L. variabilis*.* The specimens referred to *L. ceratantha* have been examined by Stephani and also by Schiffner. Stephani makes them the type of his new *Ceratolejeunea Schwaneckei*; Schiffner finds in them a mixture of two species, the one indeterminable and the other referable to *L. variabilis*.† There is no very good evidence, therefore, that *L. ceratantha* has been really found on the island. In the paper on Puerto Rico hepatics published many years later by Stephani, two other species, *L. cornuta* and *L. spinosa* are added from the collections of Sintenis,‡ but the specimens referred to *L. cornuta* were afterwards described as *Ceratolejeunea Sintenisii* Steph. *L. cornuta*, therefore, should also be considered a doubtful member of the flora. In the collections made by the writer on El Yunque, both *C. spinosa* and *C. Schwaneckei* occur in abundance, and there are also specimens of a third species which is apparently undescribed. Heller's specimens of this genus are mostly sterile but add a few fragments of what seems to be *L.* (*Ceratolejeunea*) *brevinervis* Spruce. Seven species, therefore, are known with more or less certainty from the island, and it is probable that several others remain to be discovered.

CERATOLEJEUNEA SPINOSA (Gottsche) Steph.

Lejeunea spinosa Gottsche; G. L. & N. Syn. Hep. 402. 1845.
Colura spinosa Trevis. Mem. r. Ist. Lomb. III. **4**: 402. 1877.
Lejeunea (*Cerato-Lejeunea*) *spinosa* Spruce, Hep. Amaz. et And. 211. 1884 (excluding specimens described).
Ceratolejeunea spinosa Steph. Hedwigia **34**: 238. 1895.

Dark olive-green or brownish, growing in depressed tufts: stems 0.17 mm. in diameter, prostrate and loosely adherent to the

* Linnæa **25**: 355, 356. 1852.
† Bot. Jahrb. **23**: 582. 1897.
‡ Hedwigia **27**: 285, 291. 1888.

substratum, irregularly pinnate, the branches obliquely spreading, usually short but otherwise similar to the stem: leaves imbricated, the lobe more or less convex and inflexed at the apex, falcate-ovate, 0.85 mm. long, 0.6 mm. wide, antical margin nearly straight near base and stretching partly or wholly across axis, then somewhat curved to the apex, postical margin straight or nearly so, apex broad but usually acute, margin coarsely and irregularly toothed in the apical region, teeth mostly 8 to 10, variable in size, the smallest consisting of single projecting cells, the largest about three cells long and two cells wide at the base; lobule normally of the spherical type but often poorly developed, 0.25 mm. long, 0.2 mm. wide, hyaline papilla in a distinct depression, apical sinus very short and almost straight; utriculi occasionally present; cells of lobe averaging 19 μ at the margin, 23 μ in the middle and 46 × 28 μ at the base, trigones large and often confluent, triradiate and rounded at the ends of the rays, intermediate thickenings occasional, subrotund in outline; ocelli usually absent but sometimes occurring singly at the base of the lobe: underleaves distant, orbicular, 0.35 mm. long, bifid about one half with erect triangular lobes separated by an acute to obtuse sinus, margins entire or vaguely crenulate or angular on the sides: inflorescence dioicous: female branch variable in length, sometimes much abbreviated, the flower subtended by one or rarely two simple and sterile innovations; bracts complicate, obliquely spreading, the lobe ovate, 1.1 mm. long, 0.7 mm. wide, acute, antical margin more strongly curved than the postical, irregularly spinose-dentate except near the base, the teeth mostly 10 to 20, lobule lanceolate to narrowly ovate or oblong, 0.75 mm. long, 0.25 mm. wide, margin toothed but with relatively fewer teeth than the lobe, apex acute to obtuse; bracteole connate on both sides, ovate, 0.75 mm. long, 0.4 mm. wide, bifid about one third with erect, triangular and acute lobes and a narrow sinus, margin as in the bracts but with smaller and fewer teeth; perianth immersed (except the horns), obovoid, 1 mm. long, 0.5 mm. wide, surface roughened by the convex cells, especially along the keels, beak short, horns about half as long as the main body of the perianth (0.35 mm.), contracted near the base, inflated and enlarged toward the rounded or bluntly pointed apex, more or less compressed, smooth, the two postical horns obliquely spreading, the two lateral widely spreading: ♂ inflorescence usually occupying a short branch, more rarely terminal on a longer branch; bracts in one to six pairs, inflated, shortly and subequally bifid with obtuse divisions and strongly arched keel; bracteoles at base of spike, similar to the underleaves but much smaller; antheridia single or in pairs: mature sporophyte not seen. (PLATE 19, FIGURES 1–11.)

On the bark of trees or on prostrate logs, more rarely on living leaves. El Yunque, *Evans* (*42*, *61*, *74*, *97*, *167*). Originally collected in Puerto Rico by *Sintenis* (*34*, *35*). Widely distributed in the West Indies, the type locality being St. Kitts, where it was first found by *Breutel*. It has also been reported from the following islands: Guadeloupe, *L'Herminier;* Dominica, *Elliott*, *Lloyd;* Martinique, *Duss;* St. Vincent, *Elliott;* Cuba, *Wright*. The specimens from the Andes, described by Spruce as *L. spinosa*, do not belong to this species.

C. spinosa is characterized by its dentate leaves, usually destitute of ocelli, by its strongly inflated and subspherical lobules, by its small, orbicular underleaves, by its dioicous inflorescence, and especially by the peculiar horns of its perianth, which are enlarged and inflated near the tips and yet more or less compressed. In most species where the horns are elongated, they are terete and taper gradually to a point.

Under the name *C. spinosa* var. *flagelliformis*, Stephani * has described a peculiar but sterile plant from Martinique collected by Duss. It differs from the typical *C. spinosa* in its much looser habit, the leaves being distant and the branches slender and often microphyllous, in its lobules, which are either poorly developed or else conform to the usual type of lobule found in the genus, and in its underleaves, which are more deeply bifid. Female specimens of the same plant were collected by the writer on El Yunque (*101*), where it grew sparingly on bushes. In these specimens the underleaves are occasionally subcordate at the base. The plants present every appearance of being distinct from *C. spinosa*, but in the absence of perianths it would perhaps be unwise to separate them.

Ceratolejeunea valida sp. nov.

Olive-brown, growing in depressed mats: stems 0.17 mm. in diameter, elongated, irregularly pinnate, the branches usually short and widely spreading, not microphyllous: leaves imbricated, the lobe convex and inflexed at the apex, broadly falcate-ovate, 1.1 mm. long, 0.85 mm. wide, antical margin straight or nearly so near the base, then strongly arched to the apex, postical margin less strongly arched and almost straight near the keel, apex broad,

* Hedwigia 34: 238. 1895.

sometimes rounded but usually minutely apiculate and often bearing one or two additional teeth, margin otherwise entire; lobule always conforming to the normal type, narrowly ovate in outline, strongly inflated, 0.17 mm. long, 0.09 mm. wide, keel more or less arched, slightly roughened from projecting cells, forming an obtuse angle with the postical margin of the lobe, free margin of lobule straight or nearly so, apical tooth short and slightly curved, hyaline papilla in a slight depression, sinus lunulate; utriculi frequent, occurring singly or in pairs at the base of a branch, sometimes attaining a length of 0.65 mm., free lamina strongly concave and forming a cylindrical canal leading into the sac; cells of lobe averaging 14μ at the margin, 23μ in the middle, and 40 × 28μ at the base, trigones large and often confluent, triradiate and mostly truncate at the ends of the rays, intermediate thickenings occasional, approximately rectangular or quadrate in outline; ocelli not developed: underleaves distant to slightly imbricated, nearly plane, orbicular, 0.6 mm. long, rounded at the base, bifid about one third with erect, acute or subacute lobes and a narrow sinus, margin entire, rhizoids when present springing from a rudimentary disc: inflorescence dioicous: female branch very variable in length, the flower subtended by a single, short and often floriferous innovation; bracts complicate, obliquely spreading, the lobe ovate to orbicular-ovate, 0.85 mm. long, 0.6 mm. wide, apex rounded, apiculate or subacute, margin entire or irregularly toothed near the apex, lobule ovate-lanceolate to obovate, 0.55 mm. long, 0.35 mm. wide, rounded to acute at the apex, margin entire or sparingly denticulate in the upper part; bracteole somewhat connate on both sides, broadly ovate or oblong, 0.75 mm. long, 0.6 mm. wide, bifid about one third with erect acute lobes and a narrow sinus, margin entire or with a few scattered teeth; perianth immersed (except the horns), obovoid, 1 mm. long, 0.6 mm. wide, surface roughened especially along the keels, apex broad and with a short beak, horns nearly half as long as the main body of the perianth (0.3 mm.), cylindrical or slightly compressed at the blunt apex, smooth, the two postical horns erect, the two lateral erect or somewhat spreading: ♂ inflorescence and mature sporophyte not seen. (PLATE 19, FIGURES 12–20.)

On bushes. El Yunque, *Evans* (*91*).

It is with some hesitation that *C. valida* is described as new, partly because species are so difficult to define in *Ceratolejeunea*, partly because it is so closely related to the following species. Perhaps its most striking peculiarities are found in the leaf-cells with their extremely thick walls. When these cells are viewed from the surface, especially in a flattened leaf, they present an unusual

appearance because their large trigones are truncate rather than rounded (FIGURE 15). The species is also noteworthy because it fails to develop ocelli and spherical lobules. These characteristics will help to separate it from *C. spinosa*. It also differs from this species in its entire or sparingly toothed leaves, in its larger underleaves, in its entire or less dentate bracts and bracteoles, and in the differently shaped horns of its perianth.

Ceratolejeunea brevinervis (Spruce)

Lejeunea (*Ceratolejeunea*) *brevinervis* Spruce, Jour. Linn. Soc. Bot. **30**: 342. *pl. 21. f. 6–9.* 1894.

On bark of trees and on rotten logs. North slope of the Luquillo Mountains, *Heller* (*1131 p. p., 4712 p. p.*). Also known from the following islands: Guadeloupe, the type locality, *L'Herminier;* Dominica, *Elliott;* Jamaica, *Evans.*

There is only one important respect in which *C. brevinervis* differs from *C. valida*, and that is in the possession of a false nerve running half way from the base to the apex of the lobe and consisting of a row of from six to ten ocelli. In some cases there is a second and shorter row lying next to the first. The ocelli average about 40 μ in length and seem to be entirely absent from the bracts. Heller's specimens are not typical, the horns of the perianth being shorter than usual, but this is probably because they are poorly developed.

CERATOLEJEUNEA SCHWANECKEI Steph.

Lejeunea ceratantha Hampe & Gottsche, Linnaea **25**: 356. 1852. (Not Nees & Mont.)

Ceratolejeunea Schwaneckei Steph. Hedwigia **34**: 237. 1895.

Varying in color from olive-brown to blackish, growing in depressed mats: stems 0.14 mm. in diameter, loosely appressed to the substratum, elongated, irregularly pinnate, the branches usually short and widely spreading, often with smaller leaves than the stem: leaves imbricated, the lobe convex and sometimes inflexed at the apex, falcate-ovate, 0.85 mm. long, 0.6 mm. wide, antical margin nearly straight near base, then strongly curved to the apex, postical margin varying from slightly outwardly curved to slightly incurved, often nearly straight, apex broad, sometimes rounded and entire, sometimes apiculate and sometimes with two to four irregular and scattered teeth, margin otherwise entire; lobule

sometimes conforming to the normal type and sometimes spherical; normal lobule strongly inflated, ovate in outline, 0.17 mm. long, 0.12 mm. wide, keel arched, slightly roughened from convex cells, forming an obtuse angle with the postical margin of the lobe, free margin of lobule straight or nearly so, apical tooth short and blunt, somewhat curved, hyaline papilla in a scarcely evident depression; spherical lobules 0.2 mm. long, apical tooth short and rounded, papilla in a distinct depression; utriculi often present, singly or in a pair at the base of a branch, sometimes attaining a length of 0.5 mm.; cells of lobe averaging 14 μ at the margin, 22 μ in the middle and 35 × 22 μ at the base, trigones large and often confluent, triradiate and rounded at the ends of the rays, intermediate thickenings occasional, oval to rotund in outline; ocelli often but not always present, occurring singly or in a pair at the base of the lobe, averaging 46 × 28 μ, not developed in the bracts: underleaves distant to imbricated, plane or convex when seen from below, varying in shape from orbicular and rounded or even cuneate at the base to broadly reniform and cordate at the base, 0.25–0.5 mm. long, 0.25–0.85 mm. wide, bifid one third to one half, the sinus narrow and usually acute, the divisions erect, triangular, acute to obtuse, margin entire: inflorescence dioicous: female branch variable in length but rarely very short, the flowers innovating on one or on both sides, the innovations usually short and simple; bracts complicate, obliquely spreading, the lobes ovate and connate antically at the base, 0.85 mm. long, 0.5 mm. wide, apex rounded or apiculate, margin entire or sparingly and irregularly toothed in the upper part, lobule ovate to ovate-lanceolate, 0.6 mm. long, 0.2 mm. wide, rounded to acuminate at the apex, margin usually entire but sometimes with a few scattered teeth in the upper part; bracteole connate on both sides, broadly ovate to orbicular, about 0.6 mm. long, bifid about one third with erect and acute lobes and a narrow sinus, margin entire or with one or two scattered teeth on each side; perianth immersed (except the horns), obovoid, 1.1 mm. long, 0.6 mm. wide, surface slightly roughened especially along the keels, apex broad and with a short beak, horns about 0.25 mm. long, terete and gradually tapering to the acute or bluntly pointed apex, smooth, the two postical horns erect or slightly spreading, the two lateral suberect to widely spreading: ♂ inflorescence occupying a short branch or terminal on a longer branch, sometimes proliferating at the apex; bracts mostly in three to six pairs, imbricated, strongly inflated, shortly and subequally bifid, the lobes bluntly pointed; bracteoles present at base of spike, orbicular, bifid; antheridia usually borne singly: mature sporophyte not seen. (PLATE 20, FIGURES 1–18.)

On bark of trees or on logs, rarely on rocks or on living leaves.

El Yunque, *Evans* (*26, 32, 71, 81, 118, 146, 147, 159*). North slope of the Luquillo Mountains, *Heller* (*4646*). Known only from Puerto Rico, where it was originally collected by *Schwanecke* and listed as *L. ceratantha* Nees & Mont.

The specimens quoted above have been compared with a portion of the type material of *C. Schwaneckei*, kindly communicated by its author. The species is exceedingly variable, and it is not unusual to find the whole range of variation exhibited by a single plant. The variation shows itself in the apices of the lobes, in the degree of marginal dentation, in the lobules, in the degree of thickening in the walls of the leaf-cells, in the presence or absence of ocelli. It is in the underleaves, however, that it reaches its height. In some cases these are orbicular, scarcely wider than the stem and cuneate at the base; in other cases they are broadly reniform, six times as wide as the stem and deeply cordate at the base. Between these two extremes there are all possible gradations. The bracts and bracteoles are also variable with respect to shape and degree of dentation, but they agree in being always connate with one another, thus forming a second and deeply lobed sheath around the true perianth. The horns of the latter organ do not vary to any extent except in the direction which they assume.

The utriculi are often found at the base of short and simple branches, the remaining leaves of which have spherical lobules and reduced lobes (FIGURE 4). Lobules of this sort, however, are by no means confined to such positions but frequently occur on leaves with normal lobes, either on the main stem or on leading branches.

It is not difficult to distinguish *C. Schwaneckei* from any one of the preceding species. From *C. spinosa* it may be separated by its less strongly toothed leaves and bracts, by the fact that it often develops lobules of the normal type, by the variability in the shape of its underleaves and by the tapering horns of its perianth. From *C. valida* and *C. brevinervis* it may be distinguished by the rounded thickenings of its leaf-cells, by the spherical lobules which it so often develops and by its variable underleaves.

CERATOLEJEUNEA VARIABILIS (Lindenb.) Schiffn.

Lejeunea variabilis Lindenb.; G. L. & N. Syn. Hep. 399. 1845.

Colura variabilis Trevis. Mem. r. Ist. Lomb. III. **4**: 402. 1877.

Lejeunea (*Cerato-Lejeunea*) *variabilis* Spruce, Hep. Amaz. et And. 206. 1884.

Ceratolejeunea variabilis Schiffn.; Engler & Prantl, Nat. Pflanzenfam. $\mathbf{1}^3$: 125. 1893.

On bark of trees, on rotten logs, on living leaves and on rocks. Without definite localities, *Schwanecke*, *Sintenis*. The species is said to be widely distributed in the American tropics, and the following stations may be quoted: St. Kitts, the type locality, *Breutel;* Dominica, *Elliott;* Martinique, *Husnot;* St. Vincent, *Elliott;* region of the Amazon, *Spruce*. No specimens from Puerto Rico have been seen by the writer.

C. variabilis is very closely related to the preceding species but differs from it in its autoicous inflorescence. Whether this single difference is sufficient to separate the species is a question which cannot be answered definitely at the present time.

CERATOLEJEUNEA SINTENISII Steph.

Lejeunea cornuta Steph. Hedwigia **27**: 285. 1888. (Not Lindenb.)

Ceratolejeunea Sintenisii Steph. Hedwigia **34**: 237. 1895.

Olive-brown, prostrate and loosely adherent to the substratum: stems 0.1 mm. in diameter, elongated, densely and irregularly pinnate, the branches mostly short and widely spreading, sometimes with smaller leaves than the stem: leaves imbricated, the lobe convex and more or less inflexed at the apex, falcate-ovate, 0.7 mm. long, 0.45 mm. wide, antical margin arching across the axis, rounded from very near the base to the apex, postical margin straight or nearly so, apex broad, rounded or bluntly pointed, margin entire or very minutely crenulate from projecting cells, sometimes angular-repand in the outer part; lobule conforming to the normal type, strongly inflated, broadly ovate in outline, 0.12 mm. long, 0.09 mm. wide, keel arched, almost smooth, forming an obtuse angle with the postical margin of the lobe, free margin of lobule somewhat curved, apical tooth short and blunt, slightly curved, papilla in a shallow depression, sinus lunulate; utriculi occasionally present at the base of short branches, occurring singly, 0.35 mm. long; cells of lobe averaging 13μ at the margin, 20μ in the middle and 30 × 20μ at the base, trigones large, triradiate and rounded at the ends of the rays, often conflu-

ent, intermediate thickenings occasional, oval; ocelli developed singly or in pairs at the base of the lobe, 46 × 23μ, not always present: underleaves imbricated, plane or convex from below, reniform, maximum size 0.5 × 0.7 mm., rounded to cordate at the base, bifid one fourth to one half with erect, acute to obtuse divisions and a narrow sinus, margin entire or nearly so: inflorescence autoicous: female branch variable in length and sometimes much abbreviated, the flower innovating on one side with a short and often floriferous innovation; bracts complicate, obliquely spreading, the lobe ovate to obovate, 0.6 mm. long, 0.45 mm. wide, rounded to obtusely pointed, entire or minutely crenulate, lobule oblong or ovate, 0.45 mm. long, 0.15 mm. wide, rounded to acute, entire or nearly so; bracteole slightly connate on both sides, broadly ovate, 0.6 mm. long, 0.5 mm. wide, bifid one fourth to one third with erect acute lobes and narrow sinus, margin entire or minutely crenulate; perianth about half exserted, ovoid, 0.85 mm. long, 0.35 mm. wide, beak short, surface smooth except along keels, horns about 0.15 mm. long, terete, tapering to blunt points, obliquely spreading: ♂ inflorescence occupying a short branch; bracts loosely imbricated, in three to six pairs, strongly inflated, shortly and subequally bifid, the lobes blunt; bracteoles present at base of spike, rotund, shortly bifid: mature sporophyte not seen.

Near Jabucoa, *Sintenis* (*125*), the type locality.

The description given above is drawn from a portion of the type specimen kindly communicated by Stephani. Although this specimen shows that the species is probably distinct, it does not bring out clearly the range of variation, and it may be necessary to modify the description in certain details when the plant becomes better known. For this reason it has seemed inadvisable to figure the species at the present time.

C. Sintenisii is somewhat smaller than the preceding species and is more densely pinnate. In its autoicous inflorescence it agrees with *C. variabilis* but differs from all the other species known from the island. It may also be distinguished by the absence of teeth on the leaves and bracts and by the shorter horns of the perianth.

Ceratolejeunea patentissima (Hampe & Gottsche)

Lejeunea patentissima Hampe & Gottsche, Linnaea **25**: 355. 1852.

Lejeunea (*Harpalejeunea*) *patentissima* Steph. Hedwigia **27**: 288. 1888.

Dark olive-brown, scattered: stems 0.08 mm. in diameter, irregularly pinnate, the branches obliquely spreading, not microphyllous: leaves loosely imbricated, the lobe subsquarrose, convex, strongly falcate, broadly ovate or subrotund beyond the lobule, 0.35 mm. long, 0.3 mm. wide, antical margin straight or slightly incurved near base, then very strongly outwardly curved to the apex, postical margin much shorter, more or less curved, apex broad, rounded or apiculate, margin entire or vaguely crenulate from projecting cells; lobule of the normal type, strongly inflated, narrowly ovate in outline, 0.17 mm. long, 0.08 mm. wide, strongly curved forward in the outer part with a narrow tubular opening into the water-sac, keel somewhat arched, slightly roughened, forming approximately a right angle with the postical margin of the lobe, free margin of lobule slightly curved, apical tooth rather long and tapering, abruptly curved at the base, normally reaching to the end of the keel, papilla in a distinct depression, sinus short and shallow; cells of lobe averaging 13 μ at the margin, 18 μ in the middle and 28 × 18 μ at the base, trigones large and often confluent, triradiate and with truncate rays, intermediate thickenings occasional, also truncate, walls often appearing uniformly thickened on account of the minute pits; ocellus when present single, at base of lobe, 41 × 25 μ: underleaves distant, appressed to distinctly squarrose, orbicular, 0.2 mm. long, bifid about one third with an acute sinus and erect or subconnivent, obtuse to acute lobes, margin entire or nearly so: inflorescence dioicous: ♀ inflorescence innovating on one side; bracts complicate, obliquely spreading, the lobe very much as in the leaves with the antical margin much longer than the postical, 0.7 mm. long, 0.5 mm. wide, lobule (in single specimen seen) obovate, 0.5 mm. long, 0.2 mm. wide, broad and apiculate at the apex, entire; bracteole connate on both sides, ovate, 0.6 mm. long, 0.4 mm. wide, bifid about one third with narrow sinus and erect lobes, acute or obtuse at the apex; perianth almost immersed, obovoid, 0.7 mm. long, 0.45 mm. wide, beak short, horns short and rounded, scarcely flattened, suberect: antheridial spike (the only one seen) occupying a short branch; bracts in three pairs, shortly and subequally bifid with rounded or obtuse lobes; bracteole single at base of spike, similar to the underleaves. (PLATE 20, FIGURES 19–26.)

Mixed with other bryophytes. Puerto Rico, *Schwanecke*. The species has apparently not been collected on the island a second time. It has, however, been found in Cuba by *Wright*, and a few fragments of it occur in the writer's set of the *Hepaticæ Cubenses*,

mixed with the specimens distributed as *Lejeunea ceratantha*. It has not been reported from any other localities.

Reference has already been made to this species in the discussion of the genus *Harpalejeunea*.* Unfortunately the specimens preserved as the type do not agree in all respects with the original description, the most important discrepancy being with regard to the perianth, which is said to be five-keeled at the apex. The single perianth studied by the writer is in the Hampe herbarium and is mounted on mica, so that it was apparently seen by the authors of the species. This perianth, as shown by FIGURE 21, has four blunt horns, and it would therefore appear that the original description is incorrect in attributing to the plant a five-keeled perianth. Stephani† has described a specimen of this species, also presumably a part of the type, which differs somewhat from the normal form. This specimen is said to have distant leaves with the lobe squarrose, ovate-lanceolate, and sharply pointed. A drawing of this peculiar plant, which he has kindly supplied, shows these differences clearly but agrees with the specimens described above in its lobules and underleaves. Whether it represents an admixture of another species or is simply a slender and poorly developed form of *C. patentissima* can hardly be determined.

C. patentissima is the smallest form of the genus known from Puerto Rico. The slender lobule, distinctly curved forward in the outer part, is perhaps its most striking feature. At the junction with the lobule the postical margin of the lobe curves abruptly inward, the consequence being that the outer end of the water-sac, enclosing the tubular canal, seems to be entirely free from the lobe (FIGURE 19). The true conditions can be made out only by dissection. The lobule apparently exhibits no modifications, neither spherical lobules nor utriculi having been observed. Aside from the peculiarities in the lobule, the species is remarkable for its squarrose and strongly falcate lobes, for the lack of teeth on its leaves and bracts and for its small orbicular underleaves. The walls of the leaf-cells, also, are unusual on account of their minute pits, many of the cells being apparently thick-walled throughout (FIGURE 22).

* Bull. Torrey Club 30: 547. 1903.
† Hedwigia 27: 288. 1888.

It will be seen from the foregoing discussion that our knowledge of the species in this difficult genus is still far from complete. At the present time it is often quite impossible to determine whether differences are specific in value or merely due to variation. Apparently the plants will have to be studied in the field as well as in the laboratory, to learn if possible something about the causes which induce variation in them, before we can hope for definite conclusions on certain disputed points.

YALE UNIVERSITY.

Explanation of plates 19 and 20

The figures were drawn by the writer and prepared for publication by Miss Hyatt.

PLATE 19

Ceratolejeunea spinosa (Gottsche) Steph. 1. Part of plant with perianth, postical view, × 24. 2. Part of stem, postical view, × 24. 3. Section through lobule, cut parallel with the stem, × 45. 4. Utriculus, antical view, × 35. 5. Cells from middle of lobe, × 265. 6. Section through cells of lobe, × 200. 7. Cells from antical margin of lobe, × 200. 8. Cells from apex of lobe, × 200. 9. Apex of lobule, × 200. 10. Apex of underleaf division, × 200. 11. Bracts and bracteole, × 24. The figures were all drawn from specimens collected by the writer (*97*).

Ceratolejeunea valida Evans. 12. Branch with perianth, postical view, × 24. 13. Part of stem, postical view, × 24. 14. Base of branch with utriculi, antical view, × 24. 15. Cells from middle of lobe, × 265. 16. Section through cells of lobe, × 200. 17. Apex of lobe, × 200. 18. Apex of lobule, × 200. 19. Apex of underleaf division, × 200. 20. Bracts and bracteole, × 24. The figures were all drawn from the type specimen.

PLATE 20

Ceratolejeunea Schwaneckei Steph. 1. Branch with perianth, postical view, × 24. 2. Another branch with perianth, postical view, × 35. 3. Part of stem, postical view. × 24. 4. Branch with utriculi, postical view, × 35. 5. Apices of lobes, × 45. 6. Cells from middle of lobe, × 265. 7. Cells from base of lobe with two ocelli, × 200, 8, 9. Apices of lobes, × 200. 10, 11. Apices of normal lobules, × 200. 12. Apex of spherical lobule, × 200. 13, 14. Apices of underleaf divisions, × 200. 15. Bracts and bracteole, × 24. 16. Bracteole with lobules of bracts, × 24. 17. Bracts and bracteole, the latter on the left, × 24. 18. Bracts and bracteoles, × 24. The figures were all drawn from specimens collected by the writer (*26*, *146* and *189*).

Ceratolejeunea patentissima (Hampe & Gottsche) Evans. 19. Part of stem, postical view, × 35. 20. Part of stem, antical view, × 35. 21. Perianth with bracts and bracteole, × 35. 22. Cells from middle of lobe, × 265. 23. Apex of lobe, × 200. 24. Apex of lobule, × 200. 25. Underleaf, × 200. 26. Apex of underleaf division, × 200. Figures 22 and 24 were drawn from Wright's Cuban specimens; the others were all drawn from the type specimen.

A summary of Charles Wright's explorations in Cuba

LUCIEN MARCUS UNDERWOOD

The botanical explorations of Charles Wright in Cuba laid the foundation for our knowledge of the flora of that island, but have left much to be discovered. As will be seen by the following summary, his travels were confined chiefly to the two ends of the island, leaving the great central portion largely unexplored. It is very unfortunate that the labels on his plants, at least in most of the collections where they are to be found, bear only the inscription "Cuba" or "in Cuba orientali." A serial catalogue of Wright's numbers would be of great value, made up from the data on some of the collections where they are to be found. For example, the ferns in Eaton's collection at New Haven bear the data with a much greater degree of fullness, written in from Wright's field-notes, and as Eaton published on the ferns of Wright's collections it is probable that his collection is fuller than any other in existence.* Probably the Grisebach collection of spermatophytes at Göttingen is the most complete for this group, but that of Sauvalle (now at the Estación Central Agronómica in Cuba) is very complete and is said to contain notes showing localities, as would be natural considering the plan Wright had in mind to prepare a flora of the island in connection with Sauvalle.

It appears from Wright's correspondence that a considerable portion of his collection was lost, mainly that collected in the rich tobacco region of the western end of the island (Pinar del Rio). How extensive this loss may have been, probably cannot now be estimated, but it was certainly considerable.† Wright's sojourn

* Dr. Gray (Am. Jour. Sci. III. 31 : 12. 1886) says that the collection at the Gray Herbarium is "the fullest set," but the ferns at least are better represented at New Haven.

† It seems probable that this loss must have been very great, for we are surprised at the numbers included in his sets. His numbers do not run much above 3,900, and with a flora so large as that of Cuba it seems singular that a professional collector in ten years should not have reached a much higher number, especially as there are numerous duplicates in his collection, at least among the groups of plants with which the writer is mostly concerned. The lower cryptograms were not numbered serially and he

in Cuba covered a period of nearly ten years. He arrived in Santiago de Cuba 25 November 1856, and returned to New York 9 September 1857. His second voyage brought him to Santiago 30 November 1858 and he left Havana for New York 28 July 1864. His third trip commenced in May 1865 and he returned in July 1867.

In order to determine more accurately Wright's exact route in Cuba, the writer applied to Miss M. A. Day, the librarian of the Gray herbarium, for information regarding Wright's field notes or other sources of information that might exist at Cambridge. Through her kind intervention, it was made possible to examine the extensive series of letters written by Wright, during his long residence in Cuba, to Dr. Asa Gray. These are now in the possession of Mrs. Gray and it is owing to her generosity that we were able to consult at our pleasure the long series, which consists of some two hundred finely written and often long-continued letters which are full of valuable notes on the flora. The time will come when the publication of these letters, or excerpts from them, will form a valuable commentary on Cuban plants. The tedious perusal of these letters was diversified by Wright's accounts of his experiences, some of which were almost the duplicate of our own, and more especially by the side-notes on the political situation existing in our country during the stormy and tumultuous period of the Civil War (1861–1865). It would appear that Wright was a northern Democrat, and his previous travels in the South had led him to understand the problem from a broader standpoint than many of the residents of New England, whose bias was in great measure due to this lack of exact information of the real situation, and his vigorous statements were evidently called forth by equally strong sentiments from his correspondent.

As we are concerned at present only with the matter of Wright's itinerary, we will cite only the dates and localities where the letters were written, with sufficient of the context to explain the locality and the direction of the course of exploration.

was also engaged part of the time in collecting shells and other things, especially after he met Gundlach. In Dr. Gray's *Letters* (2 : 555) these sentences explain the cause of the loss : "April 8th. It grieves my heart and will grieve yours badly when I tell you that your boxes were put under a cargo of wet sugar, which drained into them and have [*sic*] ruined the collection. . . . As to specimens to dispose of, say only one-half or one-third of the whole mass is left fit for it."

MAP ILLUSTRATING CHARLES WRIGHT'S EXPLORATIONS IN CUBA

This list of Wright's stations has been submitted to Professor F. S. Earle, Director of the Estación Central Agronómica at Santiago de las Vegas, Cuba, whose familiarity with the country has enabled him to locate certain places and estates on the map of Cuba that would have been impossible to one less familiar with the geography of the region. In time, it may be possible to locate with accuracy the remaining stations, which are as yet unknown except from the brief and often unsatisfactory hints in Wright's correspondence. The notes added by Professor Earle to the account are marked with his initial — E.

SUMMARY OF CHARLES WRIGHT'S CORRESPONDENCE WITH ASA GRAY

I

1856. 25 N Santiago.
6 D Cobre; written on third day of stay at that place.
18 D Filantropia (Mr. Bradford's estate) 12 miles from Cobre "among the mountains."
1857. 15 Ja Filantropia.
7 F Filantropia. Mentions "two high points near here," viz., Nima-nima* and Loma del Gato.
6 Mr Filantropia. Speaks of going to Saltadero.
9 Mr Filantropia. Had finished packing; had visited 4 plantations.
14 Mr Cobre.
3 Ap Santa Catalina de Guaso or Saltadero (back of Guantanamo harbor). [Probably = Caimanera. — E.]
5 Ap Santa Catalina.
23 Ap Monte Verde.
3 My " "
8 My Saltadero. [Probably the same as Caimanera, the seaport of Guantanamo. — E.]
[Here occurs a hiatus of four months in the correspondence.]
9 S At sea approaching New York.

II

1858. 30 N Santiago de Cuba.
5 D Monte Verde. "Arrived here on 3d."
17 D " "
1859. 1 Ja " "
17 Ja " "
2 F " "
15 F " "
26 F " "
8 Mr " "
26 Mr " "

* See below, under Madelina.

10 Ap Monte Verde.
24 Ap " "
14 My Monte Verde. Had collected at La Perla, a neighboring plantation; also speaks of being "within two or three minutes' walk of the virgin forest in every direction."
21 My Monte Verde.
1 Je Santa Catalina de Guantanamo.
9 Je Monte Verde.
21 Je " "
29 Je " "
5 Jl " "
12 Jl " "
16 Jl " "
5 Au " "
19 Au " "
31 Au " "
14 S " "
17 O Santiago de Cuba. "Waiting for money" [apparently a chronic condition].
6 N Josephina, a hacienda or plantation belonging to the owner of La Perla, three leagues east from Nouvelle Sophie.
17 N Nouvelle Sophie. Mentions two excursions to the Farallones from base to summit. [Probably the high mountains east of Santiago. — E.]
22 N Nouvelle Sophie. Mentions having left Monte Verde about 17 September.
26 N Nouvelle Sophie. Says "protracted stay not advisable."
9 D La Madelina, "right at foot of Nima-nima." "Mr. Baitaill tells me that the crest which I have all along on Mr. Bradford's authority called Nima-nima, is La Guinea and that the former is away over towards the seashore."
24 D La Madelina. Mentions being at La Guinea 14th and 18th.
26 D " "
1860. 10 Ja Santiago de Cuba. Speaks of going to-morrow to Guantanamo, then to Monte Verde and back by Nouvelle Sophie.
14 Ja Monte Verde. "Came from Guantanamo the 11th."
18 Ja Nouvelle Sophie.
21 Ja Santiago de Cuba.
2 F Filantropia.
24 F Nouvelle Sophie. "To-day I start for Monte Verde."
26 F Monte Verde. Speaks of plan for excursion to Mayari.
15 Mr Monte Verde. "I hope you wont let Eaton cut up these fern stems into cross sections. It seems to me simply ridiculous to attempt to exhibit the structure of a fern or palm by a cross section at any part, whereas a longitudinal section of either shows it perfectly, or the whole of it."
23 Mr Monte Verde.
8 Ap " "
16 Ap " "
1 My " "
4 My Monte Verde. "Monte Verde is nothing but a coffee estate."

[In suggesting labels Wright designates localities under judicial districts "which everybody knows" as follows:

Monte Verde = Yateras.
La Guinea = Ongolosongo [Hongolosonga. — E.].
Filantropia = " .
Nouvelle Sophie = Las Yaguas.
Josephina = Ramon].

17 My Monte Verde.
14 Jl " "
1 Au Mayari. Mentions conditions of life at Cayo del Rey, where he spent some time.
18 Au Holguin. "Arrived this morning."
(Wright apparently crossed the island directly north of Santiago and then along the north side of the island to Holguin).
22 Au Barajagua. "Left Holguin 19th and arrived here same day."
25 Au Hato del Medio. [Four miles N. W. of Alto Cedro — E.]
9 S Nouvelle Sophie. "Arrived in Cuba (= Santiago de Cuba) the 6th.
13 S Saltadero.
15 S Monte Verde.
18 S Monte Verde. "Start to-morrow for Nouvelle Sophie, thence to Cuba and Bayamo and I may go from there to Holguin."
19 S Saltadero.
20 S Saltadero. "Yesterday started for N. Sophie etc. expecting to get money in Saltadero or Cuba. To-day returned here in chase of that valueless certificate."
17 N San Juan de Buenavista. "S. W. by S. 7 leagues from Bayamo." [Probably S. E. instead of S. W., Buena Vista on new map is about 7 leagues S. E. of Bayamo.—E.]
26 N Bayamo. "Came this morning." *
16 D Nouvelle Sophie. "On my way from Bayamo I turned aside and spent two weeks at Bradford's [Filantropia]. Found a few good things at La Guinea and Loma del Gato."
1861. 4 Ja Monte Verde.
19 Ja " "
27 Ja Nouvelle Sophie.
4 F Monte Verde.
2 Mr " "
13 Mr Potosi (in Mt. Toro). "I am on an excursion through Monte Libano and Monte Toro." [Probably north of Monte Verde.—E.]
25 Mr La Catalina near Sagua de Tanamo. "Tremendous farallones all around us not so easy to climb as you might imagine."
5 My Monte Verde. "Hope to be off to-day or to-morrow for Baracoa."
3 Je Baracoa. "I came from Mata [Probably S. W. of Baracoa; on new map, Mata Cafee.—E.] yesterday, a terribly boggy place and apparently filthy enough to kill mud-turtles. I stood it two weeks or more and I am in good health." * * * "The streams are up preventing me going to the Yunque. † So soon as I can I shall pay it a visit,

* Dr. Gray (Am. Jour. Sci. III, 31: 12. 1886) says "his kind host, Dr. Don Manuel Yero, assisted him in making some profitable mountain excursions." Judging from the above dates these must have been very brief.

† El Yunque—the anvil—is a flat-topped mountain six miles from Baracoa—one of the most conspicuous features of the sky line of eastern Cuba.

which will probably detain me but a few days. Then I shall return to Guantanamo stopping a day or two in the cuchillas (mountains)."

24 Je Monte Verde. "Got home yesterday tired out and my horse more so, seven days from Baracoa collecting a little by the way."

29 Jl Monte Verde. "After resting etc. I went on the road to Baracoa as far as the point where it turns northward to cross the mountains."

7 Au Monte Verde.

12 Au " "

4 S " "

5 O Valparaiso. "Just on the edge of Monte Libano." [Seven miles due west of Monte Verde.—E.]

17 O Monte Verde. "Got back yesterday."

24 O " "

24 N Nouvelle Sophie. "On the 20th I set out on my journey which if I am prospered will end at least for a time at "la Habana."

3 D Filantropia. Mentions a day on La Guinea. [Wright then went *via* Saltadero.]

13 D Mentions three excursions on La Guinea and Loma del Gato.

16 D Bayamo. The letter was mailed from Bayamo the 17th.

1862. 2 Ja Sancto Spiritos (Santo Espiritu).

4 Ja Sancto Spiritos "Shall remain a few days" * * * "There are as many as six or eight species of palms abundant along the route I have come, several of which I have not collected."

1 F Ingenio Fermina. "Fermina is a sugar estate two leagues from Bemba" [= Jovellanos.—E.] * * * "Left Santo Espiritu the 16th." [Here Wright found Gundlach, the zoologist, with whom he made many excursions.] In this letter Wright speaks of coming to an ingenio (sugar estate) the 24th where he stayed four or five days and "the next day here." Four leagues before reaching Villa Clara he mentions coming to a very hilly savanna.

23 Mr Mejia. "In my last [there is, however, no mention of this in any letter present in the collection] I told you I was going to the Cienaga de Zapata. I am domiciled about three leagues from it — have been to it twice." [Probably S. of Navajas.—E.]

28 Mr Mejia. "Returned from another excursion to the Cienaga."

[Here occurs a brief hiatus in the correspondence.]

17 Je San José [In Pinar del Rio, near Taco Taco or Santa Cruz.—E.] [This place is mentioned in a previous letter as away S.W. of Habana.] "I have been here more than three weeks with Don José Blain, who takes some interest in botany." . . . "I was there (Habana) the last days of May. It's a nasty place." . . . "I am about 20 leagues westward of Habana right at the foot (south side) of Rangel range of mountains or Los Organos."

23 Je "Returned from a visit of two or three days to Retiro, the other place Don José mentioned, when I was in Habana six days."

4 Au Santa Cruz. "Day before yesterday returned from an excursion of a few days south and west of here into the savannas, pinales and the famous 'vueltabago'—the tobacco district." [Properly vuelta abajo.]

13 Au San José.
8 S " "
28 S San José. "Three weeks ago went on an excursion northward and westward; we were gone two weeks."
13 O San José. "Gundlach will send my horses to Guanajay 15 leagues this side of Habana so probably I shall not go there now."
25 O Habana.
29 O San José. "To-day completes my fifty-first year."
27 N San José "Last month went from Guajaibon to Las Posas to Toscana a finca of Sauvalle (seaside) returning by San Marco and San Diego de Bañon. From there I turned S.W., and went to Herradura and Consolacion returning by Almacigos, Hato Queniando, Herradura, San Diego and so home."
10 D Ingenio Esperanza, "about a league from Pinar del Rio."
13 D Langvanillas. [This was probably the residence of an engineer of the above mentioned 'ingenio' about "four leagues away" where Wright mentioned having been invited to go in the last letter.]

1863. 9 Ja San José.
13 F " "
21 F " "
31 Mr " "
10 Ap " "
30 Ap Habana.
14 My — Wright had been at Fermina "for a few days to get plants Gundlach could not bring."
25 My Concordia. "Came here ten days since." Mentions going to the coast three leagues afoot. "Shall return in a few days to San José or rather Retiro whither friend Blain has now removed — a league."
15 Je Retiro. [This is the name of a finca near Taco Taco where Don José Blain lived. — E]
15 Jl Retiro.
27 Jl Toscano. [Probably the name of a finca near the N. coast, somewhat E. of Bahia Honda. — E]
5 S Retiro.
20 S "
20 D Los Remales. "The latter part of October I crossed the mountains to the north coast to Toscano, stayed there till Nov. 15. Went to Sagua (vega) climbed Guajaibon twice; made excursion to Cajalbarra (pine ridge crossing the island) followed down the north side near the coast through La Palma, Nombre di Dios, Bajas, Mantua. From Asiento viego (the Laguna) followed the same road to the Jarela, the terminus of my travels last year." He mentions wanting to go to the cape (Cape Corrientes?) "but as there was no guide I was content to go to a point on the south coast four leagues afoot."

1864. 15 Ja Retiro. "Three days ago I returned from my excursion of eighty," "Wrote 20th from Los Remales: a day or two later went to La Grife." [In this letter Wright mentions a serious experience with some poisonous plant which caused temporary loss of eyesight.]
5 F Retiro.

14 F Retiro
7 Mr "
22 Ap "
30 Ap Retiro. "On the 25th went to the coast at a point called Daranigan. [Point on the coast west from Retiro.—E]
7 My Retiro. "Yesterday went to the hills."
19 My Retiro. "Made an excursion of ten days eastward and southward to La Concordia, San Leon, etc."
27 Jl Habana. "Came here on the 21st."
28 Jl Habana. "Passport in pocket-book, plants boxed ready to embark,"
1865. 13 Ap Weathersfield, Conn. "Shall start for Cuba before the end of the month."
24 Ap Weathersfield, Conn.

III.

9 Je* Cayo Bonito. "Down here on the edge of that grand swamp, the Cienaga de Zapata just south of Matanzas.
18 Je La Fermina; "returned yesterday."
9 Jl Matanzas.
24 Jl Janta. "Came here five or six days ago." . . . "Stayed some ten or twelve days at Palma Sola." [Probably near Matanzas or Jovellanos.—E.]
15 Au Matanzas.
4 S Habana.
21 S Balestina. [At this place the name is spelled Valestina.] † [Province of Pinar del Rio.—E.]
23 O "
7 D "
1866. 25 Ja "
13 F "
17 F "
15 Mr Retiro.
25 Mr "
3 Ap Retiro.
8 Ap Toscano.
14 Ap "
29 Ap "
2 Je Retiro. "Left Toscano at 3 m. and arrived here about sunset."
15 Je Retiro. "Went to Rangel on the 8th" . . . "*He* went again to San Cristobal on the 10th."
4 Jl Retiro.
23 Jl "
8 Au "
14 Au Retiro. "Have been making short excursions of two or three days at a time into the palm and pine savannas near the coast."

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* Dr. Gray *loc. cit.* speaks of this third trip as commenced "in the autumn of 1865." In Gray's letter to Charles Wright (Letters, 2: 540) he mentions receiving a letter from Wright at Habana dated May 9th.

† Gray *loc. cit.* says "Balestena" and speaks of it as "a cattle farm at the southern base of the mountains opposite Bahia Honda."

20 Au Retiro.
26 S "At a sawmill the last two weeks at Palacios" [near Pinar del Rio?].
10 O La Machina (this is the sawmill above mentioned).
28 O Habana.
6 N Retiro. "Spent some days in Concordia."
2 D "
4 D Retiro. "Yesterday went into the mountains" (La Palma Vega).
12 D La Machina. (Various additions to this letter were made from same place at various dates up to 20 D.)
26 D Arroyo Hondo. "To-morrow I go to Luis Lazo."
1867. 1 Ja Guane. "From Arroyo Honda I went to Luis Lazo and staid a few days."
6 Ja La Grifa.
10 Ja Los Portales de Guane. "Yesterday I left La Grifa."
21 Ja Retiro.
8 F Habana.
10 F Habana. "Went to Matanzas yesterday for money."
18 F Habana. In this letter Wright recounts troubles he had to get a passport and other papers necessary to embark for Trinidad.
19 F Habana. "Everything arranged for my voyage" [to Trinidad]. [Apparently there is a hiatus in the correspondence here].
20 Ap Trinidad. "Since I last wrote you I went in the mountains to an old cafetal now a potrero or pasture. · · · "I came here about a week ago."
24 Ap Cuba (=Santiago de Cuba).
26 Ap Sta. Catalina de Guantanamo. "Arrived this morning." In this letter Wright mentions "letter of 8th" telling of loss of "great collections of the Vueltabago." *
5 My Monte Verde. "Back again."
12 My " †

The next letter is dated Cambridge, Mass., 23 Nov. 1868, in which Wright says "Done distributing." The sets of Cuban plants run thus: 2250, 2200, 2075, 1715, 1550, 1460, 1330, 1275, 1165, 960, 780, 750, 660, 620, 560.

The only breaks in the continuity of the above correspondence are as follows:

1. That from 8 May 1857 at Saltadero to 9 September 1857 written on the steamer approaching New York. This is the longest hiatus, and what may have been Wright's journeys during this period is largely a matter of conjecture. It seems probable that this time, like the rest of his first expedition, was spent on two or three of the plantations that formed the basis of his principal explorations in the province of Santiago.‡

* *Cf.* foot-note p. 292.

† Dr. Gray (*loc. cit.*) says that Wright returned from his third visit in July 1867.

‡ Wright's single letter to Dr. Torrey during this period, preserved in the Torrey correspondence at the New York Botanical Garden, is dated 20 June 1857 from Monte Verde and bears out the above supposition.

2. That from 28 March 1862 written near the great swamp south of Matanzas (Cienaga de Zapata) to 17 June 1862 written from the province of Pinar del Rio, where he speaks of having been for "more than three weeks." There is still a hiatus of about two months concerning which we can only conjecture. It seems unlikely that this time was spent other than in the Matanzas province.

3. That from 19 February 1867 to 20 April 1867. At the former date Wright was at Habana making arrangements for a voyage to Trinidad on the south coast, and in the second he was engaged in collecting at Trinidad himself. It would seem that one intermediate letter at least was lost. It is hardly probable from our knowledge of Cuban steamship traffic (which in 1867 was surely not an improvement over the present conditions) that Wright stopped for any length of time at any intermediate station. It is highly probable that the greater part of this time was spent at Trinidad and vicinity covering a period of approximately two months. The amount of material collected at Trinidad may throw some light on this subject, when we know the stations corresponding to Wright's numbers. It is to be hoped that some one who has access to a collection made by Wright which possesses the original localities for the numbers will supplement this paper by further notes which will establish the type localities of Wright's species. Such an account would be a real contribution to our knowledge of the flora of Cuba.

COLUMBIA UNIVERSITY.

The genus Cortinarius: a preliminary study

CALVIN HENRY KAUFFMAN

INTRODUCTION

The genus *Cortinarius*, the largest genus of the *Agaricaceae*, is of special interest because of the small amount of work done on it, especially in this country. Fries in Europe and Peck in America have described nearly all the species so far reported. In recent years, Britzelmayr * has published a number of descriptions of plants found in Bavaria, Germany, where the genus seems to be well represented. That few students study the genus seriously is perhaps due to the fact that it presents certain peculiar difficulties. These, although great enough, are not more than those found in some other parts of the mycological field. Saccardo seems to think that the changing colors deter mycologists from paying more attention to the group. The fading of the colors almost immediately after maturity is certainly a troublesome factor for the beginner, and makes it less easy for him to progress rapidly in their study. For these reasons it is necessary, first of all, to make a thorough acquaintance with the various forms as they occur in their native haunts. By repeatedly collecting the same species in the same localities as well as elsewhere, one should be able at last to distinguish even closely related forms. In this way, the writer has succeeded, as he hopes, in making some small progress towards a better knowledge of the genus.

Three successive summers were spent in collecting material, special attention being paid to the habitat and variabilities of the different species. The same places were visited year after year, and in this way duplicates of the same species from the same spot were frequently obtained. The work was done at Cornell University, Ithaca, N. Y., and the rich collecting grounds in its vicinity afforded abundant material. The fine collection of colored plates of European species found in the botanical laboratory made pos-

* Hymenomyceten aus Südbayern.

sible what progress there was. To Professor G. F. Atkinson, whose enthusiasm in this phase of botany is well known, I owe the inspiration to take up and continue the study.

HISTORICAL

Like many of the generic names of the fleshy fungi, that of *Cortinarius* was bestowed upon it in the time of Persoon and Fries. In the *Synopsis Methodica Fungorum* (1801), Persoon placed "*cortinarius*" as a section under the genus *Agaricus*. Here he included 52 species. Fries, somewhat later (1836–38),* raised the group to generic rank. Saccardo gives him credit for 209 species, including some originally described by Persoon under *Agaricus*. Britzelmayr has described 64. These two men have done most of the work in continental Europe. In North America Professor Peck has described 70 species, nearly all of which belong to the State of New York. The descriptions of these are mostly published in the reports of the regents of the State of New York, beginning with the twenty-third report.

GENERAL CONSIDERATIONS

The genus *Cortinarius* is easily recognized in the field after a season's practice in collecting. The genera most closely allied to it are *Inocybe* and *Hebeloma*, and cases occur where it is at first impossible to decide where the plant in question belongs; but these instances are rather few. *Hebeloma* and *Inocybe*, like *Cortinarius*, grow on the ground. The former is usually separated by the absence of a veil when young, and the gills are paler when mature. *Inocybe* also has paler gills and spores when mature, and is, as a rule, smaller; many of its species are further characterized by cystidia on the gills. Stevenson† says "*Cortinarius* is readily distinguished by its peculiar habit, but is badly defined by artificial characters." This statement is certainly borne out by my experience. It will nevertheless be well at this point to give a brief diagnosis of the genus.

GENERIC DESCRIPTION

Fruit-body fleshy, putrescent, with a veil, this composed of silky threads which in the young plant connect the edge of the

* Epicrisis 255.

† British Fungi.

pileus with the stem. Gills persistent, dry, changing color during the process of maturing, at length powdery with the clinging spores. Trama of pileus and stem fibrillose. Spores, when mature, for the most part cinnamon-brown in mass, subochraceus to rusty-brown by transmitted light. (A more detailed description of the veil must be looked for below.)

The genus was divided by Fries into six *subgenera*. There is hardly a doubt that these will be erected, either wholly or in part, into full genera. Some writers have already done so, but until we know more of the developmental history of the various forms included in these subgenera, it seems to me a rash procedure to multiply genera. The following key, together with a diagnosis of the subgenera, is herewith presented:

Key to Subgenera

A. Pileus, or both pileus and stem, viscid.	*B.*
Neither pileus nor stem viscid.	*C.*
B. Both pileus and stem viscid or glutinous from the universal veil.	*Myxacium.*
Surface of pileus alone viscid or glutinous.	*Phlegmacium.*
C. Plant when young covered by a universal veil.	*Telamonia.*
Plant without a universal veil.	*D.*
D. Pileus hygrophanous, glabrous; color fading on drying.	*Hydrocybe.*
Pileus dry, not hygrophanous.	*E.*
E. Plants large to medium; stem stout, clavate.	*Inoloma.*
Plants small to medium; stem slender, equal, pileus subsilky.	*Dermocybe.*

MYXACIUM. Pileus fleshy, rather thin. Entire young plant covered by a universal veil which is glutinous and the shreds of which cling to the stem, making it viscous also; on drying, pileus and stem become polished.

PHLEGMACIUM. Pileus fleshy throughout, with a thin gelatinous cuticle which becomes viscid. Stem and cortina dry. No universal veil. Stout plants.

TELAMONIA. Flesh of pileus thin, or somewhat thicker on disk, scissile; pileus hygrophanous, at length covered by white, superficial fibrils, the remains of the universal veil. Entire plant when young covered by the universal veil, which remains on the stem either as partial rings or as a sheath. Partial veil soon disappearing.

HYDROCYBE. No universal veil. Pileus hygrophanous, changing color on drying. Flesh thin, scissile. The partial veil sometimes remaining as an evanescent annulus on the stem.

INOLOMA. Pileus fleshy, rather thick throughout, dry; the scales or fibrils on the surface are not due to a universal veil, but

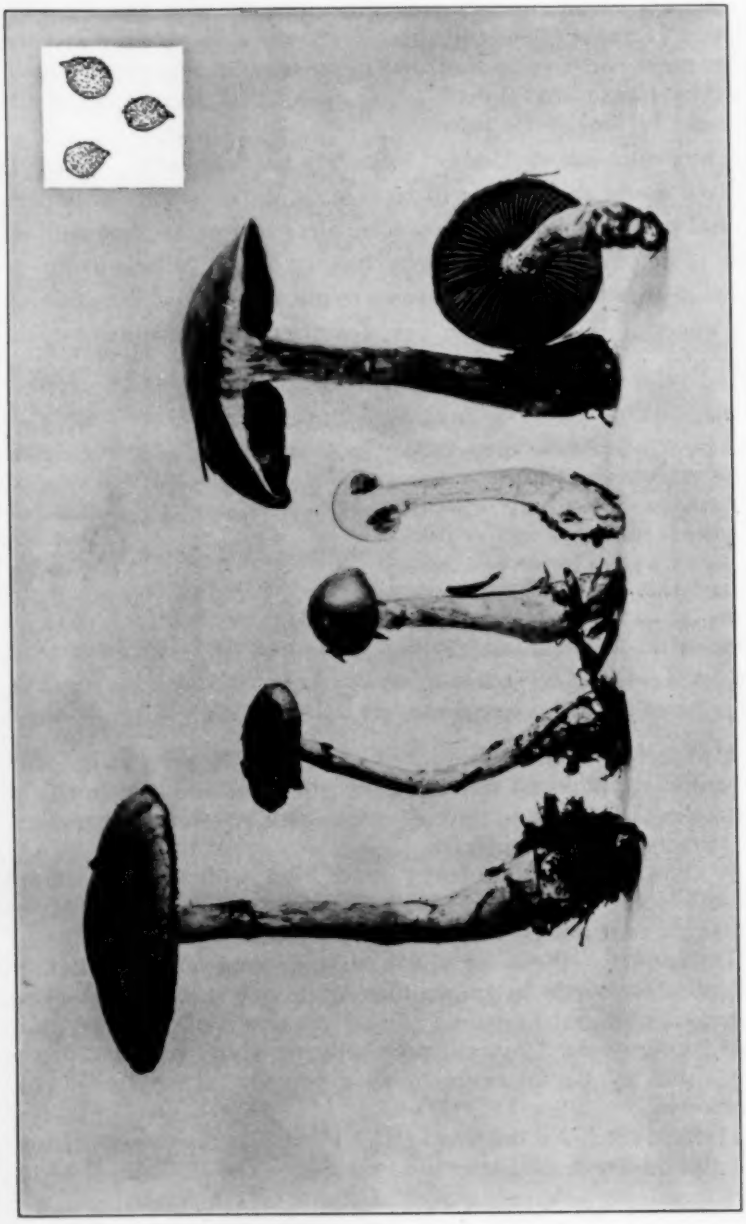

FIGURE 1. *Cortinarius sterilis* Kauff. Slightly reduced. Spores drawn with camera lucida, magnified about 750 diameters.

are loosened from the tramal tissue beneath; not hygrophanous. Stem stout and fleshy, the base enlarged and tapering upward, *i. e.*, clavate. No universal veil.

DERMOCYBE. Pileus somewhat innately silky like the preceding, but soon glabrous, dry and not hygrophanous. Flesh thin. Stem slender, rather rigid on exterior, equal or attenuated, stuffed or hollow. No universal veil. Partial veil fibrillose. Plants usually bright-colored.

STRUCTURE OF PILEUS AND STEM

There is nothing peculiar in the trama of the pileus of this genus, by which it may be distinguished from related genera. When young, the general description given by de Bary* for *Mycena*, etc., applies to everything but the veils. The hyphæ of the basal part of the young "button" are composed of rather large, oblong cells with air spaces between, these cells becoming smaller and more compact as they approach the apex of the "button," and finally end in the beginnings of the young hymenium as a dense, close-lying mass of deeply staining, minute hyphæ. At least, this is true of *C. squamulosus* Pk. and such others as have been examined. In the mature plant, the trama is largely made up of hyphæ, loosely interwoven, and containing cells, similar to those found in the basal part of the young plant; these hyphæ usually become narrower and longer in the gills, gradually changing to the still narrower subhymenial cells in the manner of many other agarics.

There is one point of interest and importance, however, which has some bearing on taxonomy. This is the cuticle or surface layer of the pileus. In the subgenus *Phlegmacium*, the cells of this layer are long and narrow, lying horizontally parallel or interwoven on the top of the trama; their walls are easily transformed, when sufficient moisture is present, into a gelatinous substance. When a vertical section is made through the surface of the pileus, and this is mounted in water, this layer widens considerably, or it may be pulled out by the razor so as to assume a more or less vertical position. Beneath this layer may be seen a transition group of cells which connect with the ordinary tramal tissue below.

In the subgenera with a dry pileus and no universal veil, the upper layer is composed of narrow, more or less long innate hyphæ, which compose the silky fibrils there met with.

* Fungi, Mycetozoa, and Bacteria 55. 1887.

FIGURE 2. *Cortinarius cylindripes* Kauft.. Reduced one-eleventh. Spores as in Fig. 1.

The tissue of the stem, as one would expect from the conditions of the young "button," is very loosely put together in the mature plant. Further study is needed to determine the exact character in certain of the subgenera. No gelatinous layer is ever present so far as known, its gelatinous character in the subgenus *Myxacium* being due to the remains of the universal veil. The tissue of the stipe is continuous with that of the pileus. The term "fibrillose" is, it seems, the accepted word to described the tramal tissue found in this genus.

CORTINA AND UNIVERSAL VEIL

The genus *Cortinarius* is said to be especially characterized by the silky veil referred to in the diagnosis of the genus. This veil has usually been called "cobwebby" or "arachnoid," because of its peculiar texture. In some of the subgenera, however, there occurs a structure which is not included in the above definition. If for example we take a highly differentiated species, such as *Cortinarius armillatus* Fr., we can observe at the proper stage what might be considered as two veils; the "cobwebby" or inner veil, also called the *cortina*, and an adjacent tissue, the *universal veil.*

The *cortina* is the tissue, composed of loose hyphae, which forms a "cobwebby" curtain in front of, *i. e.*, below the lamellae. The threads of this curtain or *cortina* seem to be inserted for some distance vertically along the stem, and converge in a wedge-shaped manner as they meet the edge of the pileus. In *C. squamulosus* Pk., it clearly coalesces with the trama of the margin of the pileus, and is therefore not superficial in that species. In the young stages of this plant — *e. g.*, when it is only 3 mm. thick — its texture is the same as later, and it seems to fill the cavity under the primordium of the lamellae. Whether this is the typical insertion of a "partial veil" into the pileus must be left an open question till I am able to examine young stages of more species. As the pileus expands and the hymenium matures, the *cortina* gradually disappears. In many cases its remains can be detected at its insertion on the stem, by the fact that the falling spores are caught in its loose meshes and remain as a cinnamon, annular stain on the upper part of the stem. In other cases the margin

of the pileus as it spreads, carries with it the shreds of the torn veil in the form of a narrow, silky decoration.

Lying adjacent to the *cortina*, and perhaps continuous with it, on its outer side, is a layer of tissue which envelops the whole plant when young, or at least the part below the margin of the pileus. This is called the *universal veil*. It is apparently not present in all the subgenera of the genus, but when present, as in *C. armillatus* Fr., it is in most cases easily recognized. The universal veil is of somewhat different texture and composition in the different species. In the subgenus *Myxacium* it is glutinous, and gives the glutinous character to the plant. In some of the species of the subgenus *Telamonia*, the hyphae which compose it are so interwoven as to make it extremely tenacious and lasting in character. Where this is the case, it is quite persistent during the later development of the plant, and is represented on the stem as a series of more or less regular bands which encircle it; or, the developing pileus breaks away in such a manner as to leave the part on the stem intact, with a resultant sheath or "stocking" clothing the stem below, in which case the stem is said to be peronate. In others — and this is usually the case in smaller species — the universal veil is quite thin and therefore more evanescent in character. The result is that the remnants of the torn veil soon disappear, or leave such a slight annulus that it is sometimes difficult to determine its existence. The resultant annulus usually occupies a medium or low position on the stem.

It is not quite clear what Fries means when in his generic description he says, "Veil arachnoid, distinct from the cuticle of the pileus, superficial."* He certainly could not have meant the universal veil in the sense in which I have used the term. Then the only interpretation possible, it seems, is to assume that he meant the cortina, which is present in all the subgenera, and that it was considered by him to be continued around the edge and over the surface of the pileus, and, if so, identical to that extent with the universal veil.

It seems that Winter † saw the ambiguity in Fries' description, for he says, "Plant fleshy, putrescent, with a cobwebby veil," with

* Epicrisis 255. 1836.

† Rabenhorst, Kryptogamen Flora, 1: 576. 1883 [2d ed.].

FIGURE 3. *Cortinarius olivacco-straminеus* Kauff. Natural size. Spores as in Fig. 1.

no mention of its connection with the pileus or of its being superficial to anything. Then in a note he adds, "*Cortinarius* is especially characterized by its velum, which consists of cobwebby threads (hyphæ), and is of a different texture from the cuticle of the pileus. This veil remains after it is finally torn, sometimes on the edge of the pileus, sometimes on the stem, etc. It is here called the cortina." It will probably be found that this cortina is not always continued over the pileus, and hence is not always superficial. The texture of the cortina and that of the surface of the pileus are certainly different in some cases. Whether the cortina is continuous in some cases with a superficial layer of the pileus; whether there is really a superficial cuticle in all the subgenera; or in what cases the cuticle, when present, is continuous with the outer layer of the veil, *i. e.*, the universal veil, must be left until more species can be studied in the young stage.

The writer believes it will aid in clearness of diagnosis of species to use the term "universal veil" for the outer layer of Fries' velum, since this tissue is differentiated to such an extent as to be easily distinguished from the cortina.

As already seen, the universal veil belongs to the subgenera *Myxacium* and *Telamonia*. As to the chances of a universal veil in the subgenus *Phlegmacium*, it may be worth while to call attention to a note by Stevenson,* under *C. turmalis*, in which he considers the scaly covering of a number of plants of the *Phlegmacium* group as the remains of the universal veil. In the subgenus *Telamonia* an important character, besides the universal veil, is said to be the hygrophanous pileus. This has made it rather difficult to place some of our American species which have a dry pileus, but which have a universal veil. Peck placed *C. flavifolius* in *Telamonia* in spite of its dry pileus. It is likely that *C. annulatus* Pk. will be found to belong there when its veil has been thoroughly investigated. A study of *C. squamulosus*, in the very young stage, showed a beautifully differentiated layer of tissue surrounding the young "button," which looks very much like a universal veil. It seems desirable to neglect the hygrophanous character in this subgenus so as to admit the above and similar species. If this is said to conflict with the natural character of the subgenus, it is

* British Fungi 2: 4.

equally true that placing it among the *Inolomata* defies the natural limits of that subgenus. No other course would then be left but to erect another subgenus, and this is not desirable. Professor Earle, it seems to me, takes the correct view when he separates *Telamonia* from the others on the basis of a universal veil.

GILLS

The *structure* and the *texture* of the gills afford no special help to the student. Britzelmayr,* it is true, considered the method of attachment of the gills to the stem as one of the most valuable characters of the genus, but this does not seem to the writer to be so important. Gillet, in his key, makes considerable use of the serration of the gills; it may be that this can be used to some extent, but it is certainly a very uncertain characteristic.

One of the most helpful characteristics, on the other hand, is *the color of the young gills.* This may be white, olivaceous, violet, blue, red or yellow in the different species, and this character was made use of by Fries to separate the subgenera into further divisions. After the gills attain maturity, these colors are all transformed into some shade of cinnamon. The final appearance of the gills is due to an intermixture of the original color of the gills, and that of the cinnamon-brown spores; this makes it possible at times, even in old specimens, to determine what was the color of the gills in the young plant.

SPORES

The *color* of the young spores is more or less hyaline, or they may be tinged with the same color as the gills. After maturity, the mass always reflects predominantly the cinnamon-brown by which we characterize the genus. Occasionally an ochraceous or yellow tinge prevails, but one can hardly agree with Fries that they are always "subochraceus supra chartam albam." The slight variation in color can hardly be used as a specific character, and Professor Peck no doubt was well aware of this when he refrained from using it in a single description.

The *shape* of the spores is more useful. They may vary all the way from a fairly spherical spore to one whose length is three

* Botanisches Centralblatt **51**: 2.

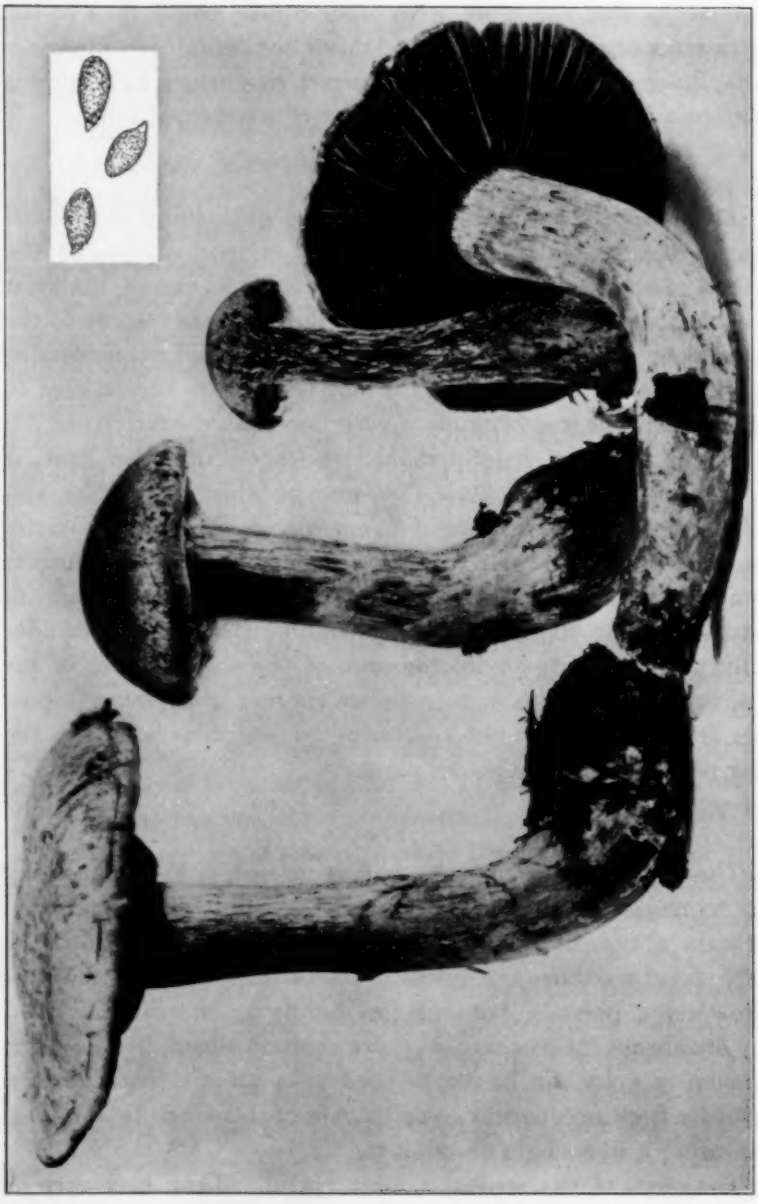

FIGURE 4. *Cortinarius umidicola* Kauff. About five-sevenths natural size. Spores as in Fig. 1.

times its width. An apiculus, or projection, is usually noticeable and represents the point where the spore is attached to the sterigma.

The spores also vary in the *structure* of the epispore. This is often covered with spiny or tubercular processes; in other cases the spores are quite smooth. In using this as a specific character one must never lose sight of the fact that when young all spores are smooth. It is therefore necessary to make sure that the spores referred to are mature.

The *size* of the spores is, in my opinion, of much greater value for diagnostic purposes, than has hitherto been recognized. There is no doubt that the size of the spores of a single individual varies, and that it varies when there is every evidence that the spores are mature. But that they vary within limits, which are sufficiently constant, any one can determine for himself. One need only take measurements of a great many spores from a number of individuals of an easily recognized species (it is hoped that there are a few such species). One finds, indeed, a certain number of abnormal spores which are larger or smaller than the majority. But these should not be taken into account. It is time that we look more closely into the microscopical characters of these plants, and it is a pleasure to read Mr. Massee's discussion of this point in his recent monograph of the genus *Inocybe*.*

The spores of the genus *Cortinarius* have in all cases examined been found constant within limits. These limits are at times remarkably narrow, at other times just as remarkably wide. For example, a plant which has usually been called *C. alboviolaceus* Fr. in this country, has spores, which at maturity, are from 6.5 to 9.5 μ long, — it is meant by this that the average spores found in the field of the microscope in several mounts, and of as near the mature color as possible, are within these limits. A few may be longer, a number of younger, paler ones are shorter, but spores from this same species always show this same variability. On the other hand, *C. annulatus* Pk. has rather constant spores, somewhat spheroid, 7 μ long by 6.5 μ broad. In this case a single figure is sufficient to denote the length or breadth.

Several species have been studied in prepared sections, in which

* Ann. Bot. 18: 459.

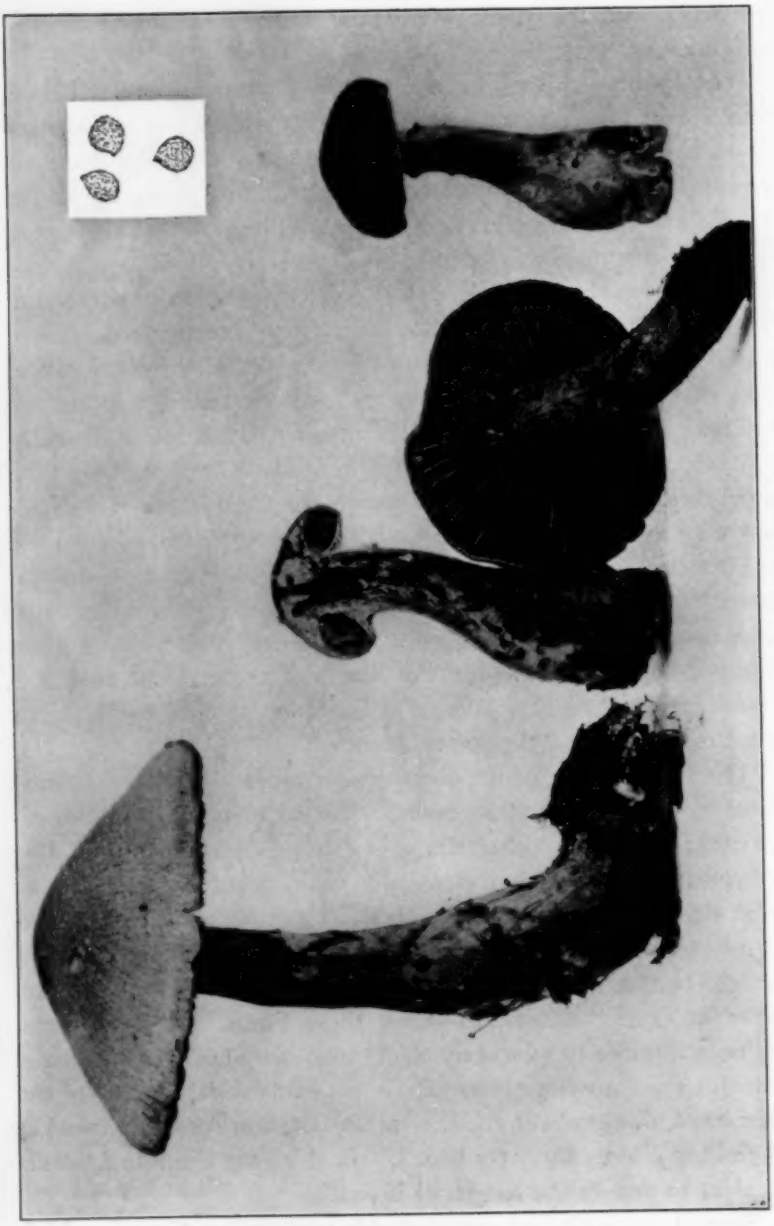

FIGURE 5. *Cortinarius crococolor* Kauff. Natural size. Spores as in Fig. 1.

binucleate spores are evidently the rule. This, however, is not the place to discuss the matter further.

Of how much value the basidia are as specific characters, has not yet been determined to my satisfaction.

HABITAT

There is little difficulty in getting material for the study of the genus *Cortinarius*, once its haunts are known. One may tramp a whole day through the woods, and hardly find a specimen, even in proper season. As is well known, the genus is eminently *northern* or found in temperate altitudes, and this, with the fact that they occur in the *autumn*, would indicate that they love the cool wood and shady brook. In the region of pine and spruce, or in old beech forests, where the shade is dense and the ground is saturated with moisture — there one may nearly always find spots where they abound. Especially is this the case when the forest covers a hill or ravine along whose slope are found rivulets at intervals of a few yards. Even then one is impressed with the remarkably local character of their occurrence. They need a substratum which is capable of retaining moisture for a considerable time, because they are slower of development than are many others of the fleshy mushrooms. Moisture and the nature of the forest trees seem, as far as at present known, to determine their home. I have collected as many as twenty species within a radius of a few rods. Sometimes a single beech tree is the centre, around which can be found a half dozen or more kinds. Such a case was a swamp of maple, oak and young hemlock, in which a beech tree, standing by itself, was the center of a 15-foot radius, and within the area made by it were found: a troop of 32 specimens of *C. squamulosus* Pk.; also *C. multiformis* Fr., *C. bolaris* Fr., *C. torvus* Fr., and three smaller kinds which were not identified. On entering a new field, a beech forest was invariably a successful collecting ground, when near-by places yielded nothing. So far, our plants were found more often near beech or hemlock. Whether there is some symbiotic relation is an interesting question.

IDENTIFICATION

To make this paper as useful to the beginner as possible, and at the same time further the study of the plants of this interesting

FIGURE 6. *Cortinarius Atkinsonianus* Kauff. Natural size. Spores as in Fig. 1.

genus, it will be necessary to point out a few matters relating to their collection and study. It is sometimes desirable to send away one's specimens for identification, and a lack of certain observations that should have been made in the field may prevent any one from giving them much attention.

It is absolutely useless to pick up an old, dried specimen of *Cortinarius*, and ask any one to recognize it. Once in a while some easily known plant may be recognized in that way, but in the majority of cases old plants of different species look so much alike that it is mere guessing to say anything about them. The first thing to remember is that young, unexpanded plants must be examined as well as mature ones. Next a careful description must be made, *with special reference to the difference in the color of the gills in the young and old plants.* Then a similar comparison of the color of pileus and stem; and then a search for an annulus or universal veil, and its character. Finally a careful test of the pileus and stem for gluten or viscidity. (One must remember that old, dry plants may lose this character.) These points are absolutely essential. In addition to the above, the following characters are often useful: the shape of the pileus; the size of the parts; the smoothness of the surface of pileus and stem; the character of the edge of the gills; the nature of the bulbous base of the stem; the appearance of the flesh. In fact, the notes cannot be too full, *provided they contain the essential facts mentioned first.*

SPECIES

In working over the material, it was found that the chief difficulty lay in the lack of an extensive key to the American species. It is true that Professor Earle * has compiled one from the descriptions of the authors; and although his key sometimes gave me a clue to a species, it also led me astray. This is not so much a reflection on the key — which is admittedly a compilation — it rather shows how unsatisfactory are studies which are made from the descriptions alone. The key which is here presented, although worked out and tested on fresh plants alone, must necessarily have many shortcomings. The possibility of mistaking descriptions of species, especially of European origin, is great. Photographs and

* Torreya 2: 169, 180. 1902.

colored drawings have been made of all the species presented in the key. These, with the dried specimens, have been compared with the type specimens of Professor Peck at Albany, or with European exsiccati in the Cryptogamic Herbarium of Harvard University. The writer here wishes to acknowledge the kindness and courtesy shown him by both Professor Farlow and Professor Peck.

The species included in this key are only such as were found in the vicinity of Ithaca, N. Y., and which could, with a high degree of certainty, be identified. Almost as many more, not included in the key, need further study. It is hoped that the list may not be less useful to students in other localities, even if it is local. Most of the European species included have been reported for New York by Professor Peck.

The natural relationships of the species have been more or less violated in the key, since its maker has had in mind not a final grouping, but a help for beginners.

A PARTIAL KEY TO THE CORTINARII IN THE VICINITY OF ITHACA, N. Y.

A. Pileus with a gelatinous cuticle, more or less viscid or glutinous when moist, as is also the stem in some species. [*Myxacium* and *Phlegmacium*.]

Pileus coarsely corrugate. *C. corrugatus* Pk.

Pileus not corrugate.

Taste of the surface of the pileus extraordinarily bitter; plants small.

C. vibratilis Fr.

C. amarus Pk.

Taste not very bitter.

Spores large, 10 to 16 μ long.

Stem cylindrical and long; entire plant very viscid.

Stem with evanescent scales, or none.

C. cylindripes sp. nov.

Stem with broken, concentric rings of floccose scales.

C. collinitus (Pers.) Fr.

Stem bulbous or short.

Spores 10–12 μ long.

Color very pale yellow with olivaceous tinge.

C. olivaceus-stramineus sp. nov.

Color yellow to orange-ochraceous; no olivaceous tinge.

C. multiformis Fr.

Spores 13–16 μ long; stem violaceous to blue.

C. Atkinsonianus sp. nov.

Spores smaller, 6–9 μ long.

Pileus with dark olivaceous tinge.
C. anfractus Fr.
Pileus with a violaceous or purple color.
Flesh and gills turning purple when bruised.
C. purpurascens Fr.
Flesh not turning purple.
Stem with marginate bulb.
C. caerulescens Fr.
Stem clavate or slightly bulbous. (Pileus sometimes almost pale yellow.)
C. Berlesianus Sacc. & Cub.
Stem subequal; plants small.
C. croceo-caeruleus (Pers.) Fr.
Pileus some shade of yellow; no tinge of violet.
Pileus covered by gluten; stem viscous when moist.
C. sphaerosporus Pk.
Pileus not covered by gluten; pileus deep tawny-orange; stem marginate-bulbous.
C. fulgens (Alb. & Schw.) Fr.
Pileus some shade of drab. *C. sterilis* sp. nov.

B. Cuticle of pileus not composed of gelatinous fibers, hence never viscid nor gelatinous. [*Inoloma*, *Telamonia*, *Dermocybe*, and *Hydrocybe*.]
Spores 10–12 μ long; plants not whitish nor violaceous.
Plants small, 2–4 cm. tall. *C. badius* Pk.
Plants longer, about 8 cm. tall.
Stem with cinnabar-colored, persistent, concentric rings.
C. armillatus (Alb. & Schw.) Fr.
Stem sheathed by the veil, *i. e.*, peronate.
C. torvus Fr.
Spores 4–9 μ long; if longer, plants are whitish or violaceous.
Stem and pileus scaly or shreddy.
Scales red (scarlet to vermillion). *C. bolaris* (Pers.) Fr.
Scales brown to blackish.
Plant large, watery-spongy, soon dark chocolate-colored.
C. squamulosus Pk.
Plants of medium size, wood-brown.
C. pholideus Fr.
Stem not scaly.
Stem with more or less persistent annular rings or peronate.
Plants large, 1–8 cm. or more tall; pileus proportionately broad.
Pileus ochraceous, clay-colored, or tawny.
Stem at first peronate by the white universal veil; pileus at first buff. *C. flavifolius* Pk.
Stem at first peronate by the tawny-yellow universal veil; pileus at first tawny-yellow.
C. annulatus Pk.
Entire plant saffron-yellow.
C. croceocolor sp. nov.
Pileus bluish to purple when young; buff to tan when old.

Stem stout, 10–20 mm. thick; pileus punctate.
C. umidicola sp. nov.
Stem more slender, 5–10 mm. thick; pileus not punctate.
C. deceptivus sp. nov.
Plants small, subannulate; pileus less than 3–4 cm. broad.
Pileus watery-cinnamon, smooth.
C. lignarius Pk.
Pileus fuscous, when young covered with white, villose fibrils.
C. paleaceus (Weinm.) Fr.
Stem with no annulus, or annulus evanescent.
Stem bulbous or clavate.
Bulb depressed-marginate; gills heliotrope-purple when young.
C. obliquus Pk.
Bulb clavate.
Color of plant lilac to whitish.
Plants usually larger than in the next; lilac color persistent. *C. lilacinus* Pk.
Plants of medium size; violet tinge evanescent.
C. alboviolaceus (Pers.) Fr.
Color of pileus some shade of buff.
C. caespitosus Pk.
Color of entire plant deep-chrome, unchanging.
C. callisteus Fr.
Stem subequal or tapering downward.
Pileus not hygrophanous.
Pileus cinnamon-colored; stem yellow; no olivaceous tinge.
Gills at first yellow.
C. cinnamomeus (L.) Fr.
Gills at first flame-scarlet.
C. semisanguineus flamineus var. nov.
Gills at first dark blood-red.
C. semisanguineus Fr.
Pileus tawny-olive; stem yellow, olive-tinged.
C. croceus Fr.
Pileus and stem scarlet or blood-red.
Pileus broad as compared with the rather short stem; spores 8 x 5 μ. *C. cinnabarinus* Fr.
Pileus narrower, stem longer; spores 6 x 4 μ.
C. sanguineus (Wulf.) Fr.
Pileus distinctly hygrophanous.
Plant small; pileus 2 cm. broad or less.
Pileus conical at first; stem slender.
C. subflexipes Pk.
Pileus convex at first.
Stem stout, smooth; pileus chestnut-colored.
C. castaneus (Bull.) Fr.
Stem slender, fibrillose; pileus fuscous.
C. fuscoviolaceus Pk.
Pileus broader than 2 cm.

Pileus tawny-orange to cinnamon; stem pale.
C. armeniacus (Schaeff.) Fr.
Pileus watery-cinnamon; gills very distant.
C. distans Pk..

Cortinarius sterilis sp. nov.

(*Myxacium*)

Pileus 1.5–4.5 cm. broad, suborbicular when young, then convex-expanded, margin incurved, drab, drab-gray to olive-buff (Ridg.),* even, smooth, *viscid*, somewhat umbonate at times. Flesh white, soft, thin. Gills relatively broad, 4.6 mm., drab-gray (Ridg.) at first, then light cinnamon, rounded behind, then emarginate, not at all ventricose, rather crowded; edge serratulate and white, later eroded, *provided with sterile cells.* Cortina white or sordid. Stem 4–8 cm. long, 4–6 mm. thick, at base 10 mm., hence clavate or tapering upward, solid, spongy, dingy-white, tinged towards apex with light blue, clothed when fresh with the delicate patches of the *viscid*, universal veil, which is of the same color as the pileus, within pale bluish at apex, white below. Spores 6–7 $\mu \times$ 5–6.5 μ, subspheroid, rather smooth. Plants slender. (FIGURE 1.)

Low places, near sphagnous swamps, near Freeville, N. Y. August 1904, *C. H. Kauffman.*

Cortinarius cylindripes, sp. nov.

(*Myxacium*)

Pileus 3–7 cm. broad, *very glutinous at first* and shining, later opaque, at the very first lavender, then yellowish with a violaceous tinge, at length becoming brownish-ochraceous, with the appearance of being stained by these colors at various stages, obtusely orbicular when young, then campanulate and expanded, rather small in comparison with the length of the stem; margin incurved and pellucid-striate; surface smooth, at length longitudinally wrinkled. Flesh thick on disk, thin elsewhere, violaceous, soon dingy-white. Gills rather broad, at length 5–8 mm., adnate, emarginate, not attenuate towards margin of pileus, *violaceous or lavender when young*, becoming pale cinnamon, not crowded, thin, edge serratulate and paler, somewhat wrinkled at the sides but not veined. Stem 8–10 cm. long, 5–9 mm. thick, elastic, *remarkably equal*, covered by a violaceous, *glutinous*, universal veil which sometimes remains as evanescent patches and at its junction with the partial veil as a slight annulus, smooth or fibrillose-striate at

* Ridgeway, Nomenclature of colors.

apex, violaceous to dingy-white within, solid or stuffed; *entire stem usually a beautiful pale azure-blue.* Spores 12–15 $\mu \times 6.5$–8 μ, slightly tuberculate; basidia about 10 μ long. (FIGURE 2.)

Gregarious, rarely cespitose. Entire plant is soft and quickly decays. Under hemlock trees, Enfield Gorge, Coy's Glen and Fall Creek Ravine, July to September, 1903–4, *C. H. Kauffman.*

Related to *C. elatior*, from which it differs in its equal stem, which is never scaly and is always violaceous to blue; the gills are lavender when young and the whole plant is very viscous.

Cortinarius olivaceo-stramineus sp. nov.

(*Phlegmacium*)

Pileus 4–7 cm. broad, viscid from a gelatinous cuticle, broadly convex, slightly depressed in the center when expanded, margin incurved for some time, *pale straw-yellow with an olivaceous tinge*, slightly rufous-tinged when old, smooth or silky-fibrillose, disk sometimes covered with minute squamules, shreds of the partial veil attached to the margin when expanded. Flesh *very thick*, becoming abruptly thin towards margin, white, dingy-yellowish in age, *soon soft and spongy.* Gills rather narrow, 7 mm. broad, sinuate-adnexed, whitish at first, then pale cinnamon, crowded, edge serratulate and paler. Stem 6–8 cm. long, 5–12 mm. thick, with a slight bulb when young, from whose margin arises the dense partial veil; white and very pruinate above the veil, which remains as dingy fibrils stained by the spores, spongy and *soft* within, becoming somewhat hollow. Veil white with an olive tinge. Spores 10–12 $\mu \times 5.5$–6.5 μ, granular within, almost smooth. Odor agreeable. (FIGURE 3.)

To be placed under the division "*scaurus*," where it comes near *C. herpeticus* Fr., but the gills when young are never violet-tinged.

Near Green-Tree Falls, and Freeville, N. Y., August, 1903, *H. H. Whetzel* and *J. M. Van Hook.*

Cortinarius umidicola sp. nov.

(*Telamonia*)

Pileus as much as 16 cm. broad (generally 6–7 cm. when expanded) hemispherical, then convex and expanded, with the margin for a long time markedly incurved; *young cap heliotrope-purplish* with umber on disk, or somewhat fawn-colored (Ridg.), *fading very quickly to pinkish-buff*, in which condition it is usually

found; margin when young with narrow strips, of silky fibrils from the universal veil; pileus when old covered with innate, whitish, silky fibrils, hygrophanous; *surface punctate*, even when young. Flesh of stem and pileus lavender (Ridg.) when young but soon fading to a sordid white, thick on disk, abruptly thin towards margin, soon cavernous from grubs. Gills very broad, as much as 2 cm., *at first lavender*, soon very pale-tan to cinnamon, rather distant, thick, emarginate with a tooth, at first plane then ventricose; edge slightly serratulate, concolorous. Stem as much as 13 cm. long (usually 8 to 10 cm.), 1–2 cm. thick, usually thickened below and tapering slightly upwards, mostly thicker also at apex, rarely attenuate at base, sometimes curved, always *stout*, solid, lavender above the woven, sordid white, universal veil, which at first covers the lower part as a sheath, but soon breaks up so as to leave a band-like annulus half-way or lower down on the stem, or remains on the base of the stem as white fibrillose patches; soon of same color as pileus, hygrophanous, soon cavernous. The annulus is easily rubbed off, leaving a bare stem. Cortina violaceous-white. Spores 7–9 μ × 5–6 μ, almost smooth; basidia about 40 μ long. (FIGURE 4.)

Troops of 25 plants were found under a clump of hemlock trees on the edge of a swamp, north of Freeville, N. Y., August 29, 1903, and August 22, 1904, *C. H. Kauffman.*

Cortinarius croceocolor sp. nov.

(*Telamonia*)

Pileus 3–7 cm. broad, convex then expanded, saffron-yellow, with dense, dark brown, erect squamules on disk; whole surface has a velvety appearance and feel, scarcely hygrophanous, even. Flesh of pileus yellowish-white, rather thin except on disk, slightly hygrophanous, scissile. Gills cadmium-yellow (Ridg.), moderately distant, rather thick, emarginate, rather broad, 8–9 mm., width uniform except in front where they taper quickly to a point. Stem 4–8 cm. long, tapering upwards from a thickened base, *i. e.*, *clavate-bulbous*, 9–15 mm. thick below, *peronate three-fourths of its length by the chrome-yellow to saffron veil*, paler above the veil, solid, saffron-colored within, hygrophanous, soon dingy, attached to strands of yellowish mycelium. Spores subspheroid to short-elliptical, 6.5–8 × 5.5–6.5 μ, echinulate when mature. (FIGURE 5.)

Gregarious or solitary in mixed woods, August 1904, Coy's Glen and Mich. Hollow swamp, Ithaca, N. Y., *C. H. Kauffman.* Entire plant is often saffron-colored.

Cortinarius Atkinsonianus sp. nov.

Pileus 8 cm. broad, expanded, *wax-yellow or gallstone-yellow to clay-colored and tawny* (Ridg.), colors very striking and sometimes several present at once, *viscid*, smooth, even, somewhat shining when dry. Flesh thick, except at margin, bluish-white like the stem, or paler, scarcely or not at all changing when bruised. Gills comparatively narrow, 6–8 mm., width uniform except near outer end, adnate becoming slightly sinuate, *purplish* to yellow, then cinnamon. Stem *violaceous-blue*, 8 cm. long, 12–15 mm. thick, equal or slightly tapering upward, *bulbous* by a rather thick, marginate bulb 3 cm. thick, hung with the fibrillose threads of the universal veil, which is a beautiful pale-yellow and clothes the bulb even at maturity; violaceous-blue within, solid. Spores 13–15 $\mu \times 7-8.5\ \mu$, *very tubercular*. (FIGURE 6.)

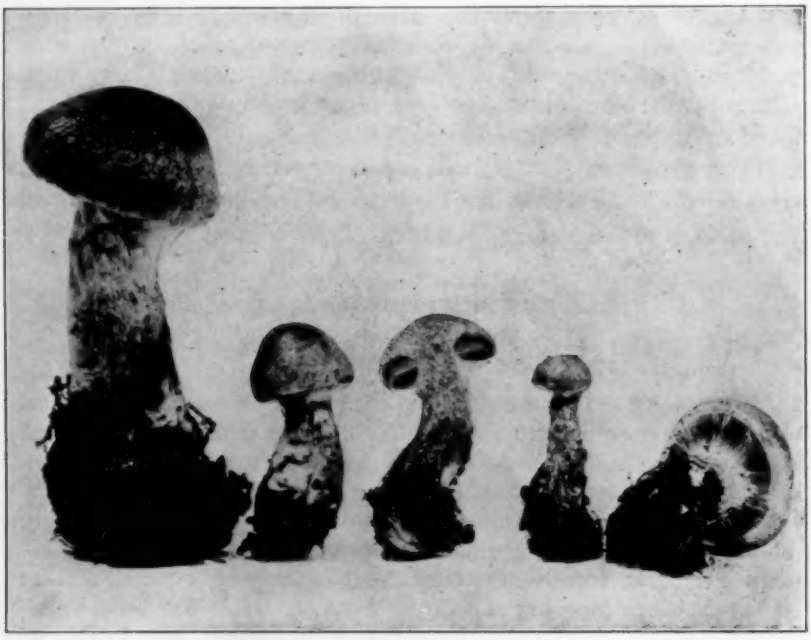

FIGURE 7. *Cortinarius deceptivus* Kauff. Slightly reduced. Young stages.

The nature of the universal veil indicates its position in the subgenus *Telamonia*, but the viscid cuticle bars it. It needs further study. Only a single, rather mature specimen was found, among hemlocks and poplars, at the base of a sassafras sapling, Enfield Gorge, near Ithaca, N. Y.. September 14, 1903, *C. H. Kauffman.*

Cortinarius deceptivus sp. nov.

(*Telamonia*)

Pileus 1–7 cm. broad, suborbicular to hemispherical, becoming convex-campanulate, *fawn-colored*, tinged with lavender, the lavender tints fading very quickly to pure fawn or light tan, disk alutaceous-buff (Ridg.), covered all over with minute brownish squamules when young, becoming subglabrous, somewhat hygrophanous, rugulose in age. Flesh hygrophanous, pallid with a *strong lavender* tinge when young, which fades out quickly, becoming the color of new cork, thick on disk, thin towards the margin; texture spongy. Gills 3–5 mm. broad, *thick*, moderately close, adnate, emarginate, attenuate at the margin of pileus, *lavender when young*, fading to pale tan when old. Stem rather stout when young, *becoming slender*, 3–6 cm. long, thickened below and tapering upward, *i. e.*, clavate, solid, covered when young by the thick fibrillose universal veil which is *lavender*, fading to white, and remaining as oblique, fugacious, brownish scales or partial rings, these terminate above in the remains of the partial veil which are stained by the spores. Spores 7–9.5 μ × 6–7 μ subspheroid to broadly elliptical, rough. The colors and shapes of the plant are very variable and deceptive. Odor not characteristic. (FIGURE 7.)

Common in hemlock woods. Gregarious. On ground and among remains of very rotten logs and brush-heaps, in Coy's Glen, near Ithaca, N. Y., August and September, 1902–1904, *C. H. Kauffman.*

UNIVERSITY OF MICHIGAN.

A Ficus confused with Proteoides

EDWARD WILBER BERRY

(WITH PLATE 21)

The genus *Proteoides* was founded in 1866 by Heer to include leaves which he considered as belonging to some member of the *Proteaceae*, but which it was not possible to determine more precisely. Since that date this genus has been the receptacle for those more or less lanceolate, somewhat coriaceous leaves with an obscured venation, which are so common during the latter part of the lower and the first part of the upper Cretaceous. The genus undoubtedly includes some forms whose affinities are with the *Proteaceae*, although I venture to advance the opinion that such an affinity on the part of the American leaves usually referred to this genus is very doubtful.

The species with which I am principally concerned, and with which I am most familiar, is *Proteoides daphnogenoides* Heer, described originally from the Dakota group of Nebraska, and since found to be exceedingly plentiful in the Atlantic coastal plain during the Mid-Cretaceous.

I have for a considerable time been of the opinion that this leaf was not Proteaceous, and this opinion seems to have been at least suggested to Newberry in regard to the Raritan leaves, at least what he says implies that while he is sure that his leaves are identical with those of Heer and Lesquereux from the West, he is doubtful if their specimens were correctly identified. Hollick * is more definite, saying of the Staten Island leaves that they are identical with Newberry's Raritan leaves whether the latter are correctly identified or not.

Without considering any arguments based on the distribution of the *Proteaceae* in the living flora we may note that *Proteoides daphnogenoides*, of the coastal plain, while agreeing exactly with Lesquereux's characterization based on the western forms, even to the

* Hollick, Ann. N. Y. Acad. Sci. 11 : 420. 1898.

very prominent midrib, differs from the existing Proteaceae (*Protea*, etc.) in being less coriaceous, and in the character of the venation, which in the latter is somewhat irregular, with the secondaries springing from the midrib at an acute angle and curving outward instead of upward, and showing a further tendency to be massed from the region of the base, which often lacks a petiole.

The leaves of *Proteoides daphnogenoides* on the other hand, more especially those of Newberry, Hollick, and Berry, are generally larger in size, with an extended and narrowly lanceolate apex, petiolate, and with regular camptodrome secondaries.

Heer's type specimens, which are mere fragments, have some long ascending secondaries but Lesquereux's more complete specimens from the same locality are unquestionably identical with the coastal plain specimens, which latter often show the venation characters. The midrib of all the specimens is fairly stout and very prominent, leaving a deep furrow on impressions; the secondaries are very fine and regular and not readily discernible.

With the idea that these leaves might be referable to the genus *Ficus*, I have examined with considerable care the herbarium material of *Ficus* at the Columbia University herbarium and that of the New York Botanical Garden.

I find numerous points of resemblance, and it may be noted that the produced apex of *Proteoides daphnogenoides* is a character common to a number of species of *Ficus*, where it is even more emphasized. A number of different species from such widely separated localities as Central and South America and the Celebes show points of resemblance to the fossil leaf. Especially among the Mexican and Central American species, do we find very similar forms, *e. g.*: *Ficus sapida* Miq., *Ficus ligustrina* Kunth & Bouché, *Ficus lancifolia* Hook. & Arn., and *Ficus fasciculata* Watson, particularly the first, which has much the same outline and consistency, the same prominent midrib, and the same regularly camptodrome venation.

In turning over the herbarium sheets one is strongly impressed with the conviction that in *Proteoides daphnogenoides* we have another and widespread *Ficus* from the Mid-Cretaceous, which flourished along the ancient coasts of the Atlantic continental mass from Long Island, New Jersey, and Maryland around its then

southern border in Alabama, and on the shores across the Mediterranean sea of that period, from Nebraska and Kansas. Lesquereux in 1892 described a large leaf of the same type as a new species of *Ficus* (*i. e., F. proteoides*), thus recognizing its true relations as well as its resemblance to the supposed species of *Proteoides*.

I have not had any opportunity to examine the leaves of this species from Alabama or from the Cheyenne sandstone of Kansas, but as both determinations were by Professor Ward I have no doubt that they are not distinct from the other leaves referred to this species of *Proteoides*.

Placed in the genus *Ficus*, where it seems to me they rightfully belong, these leaves find their affinity in the group which includes, among others, such species as *Ficus elongata* Hosius, *Ficus Berthoudi* Lesq., *Ficus suspecta* Velen., *Ficus Krausiana* Heer, etc.

The accompanying plate will give a good idea of the character of these leaves and includes a nearly complete specimen (FIG. 3) from a new locality (Grove Point, Maryland) recently collected by the writer. It will be noticed that the examples of eastern leaves show the venation much more clearly than do the western specimens.

Following is the synonymy and distribution:

Ficus daphnogenoides (Heer)

Proteoides daphnogenoides Heer, Phyll. Crét. d. Nebr. 17. *pl. 4. f. 9,10.* 1866.— Lesq. Cret. Fl. 85. *pl. 15. f. 1, 2.* 1874; Fl. Dak. Group 90. 1892.— Hollick, Trans. N. Y. Acad. Sci. **11**: 98. *pl. 3. f. 1, 2.* 1892; **12**: 36. *pl. 2. f. 4, 9, 13.* 1893; Bull. Torrey Club **21**: 52. *pl. 177. f. 1.* 1894; Ann. N. Y. Acad. Sci. **11**: 420. *pl. 36. f. 1–3.* 1898. — Smith, Geol. Coastal Plain of Ala. 348. 1894.— Newberry, Fl. Amboy Clays 72. *pl. 17. f. 8, 9; pl. 32. f. 11, 13, 14; pl. 33. f. 3; pl. 41. f. 15.* 1896.— Gould, Am. Journ. Sci. IV. **5**: 175. 1898. — Berry, Bull. N. Y. Bot. Gard. **3**: 74. *pl. 51. f. 6–9.* 1903.

Ficus proteoides Lesq. Fl. Dak. Group 77. *pl. 12. f. 2.* 1892.

Dakota Group: Nebraska and Kansas.

Raritan formation: New Jersey.

Cretaceous: Staten Island, Long Island, Cliffwood, N. J., and Grove Point, Maryland.

Mill Creek series: Mill Creek, British N. W. Territory.

Tuscaloosa formation: Alabama.

Cheyenne sandstone (Comanche series), Chatman Creek, Kansas.

Explanation of plate 21

(Figures two-thirds natural size)

FIGS. 1, 4. After Lesquereaux, 1874.
FIG. 2. After Hollick, 1894.
FIG. 3. From Grove Point, Maryland.
FIG. 5. Lesquereux's type of *Ficus proteoides*.
FIG. 6. From Cliffwood, N. J.
FIG. 9. After Newb. *pl. 17. f. 9.*
FIGS. 13, 14. After Newb. *pl. 32. f. 13, 14.*

PASSAIC, NEW JERSEY,
February 24, 1905.

INDEX TO AMERICAN BOTANICAL LITERATURE

(1901-1903)

The aim of this Index is to include all current botanical literature written by Americans, published in America, or based upon American material; the word America being used in its broadest sense.

Reviews, and papers which relate exclusively to forestry, agriculture, horticulture, manufactured products of vegetable origin, or laboratory methods are not included, and no attempt is made to index the literature of bacteriology. An occasional exception is made in favor of some paper appearing in an American periodical which is devoted wholly to botany. Reprints are not mentioned unless they differ from the original in some important particular. If users of the Index will call the attention of the editor to errors or omission their kindness will be appreciated.

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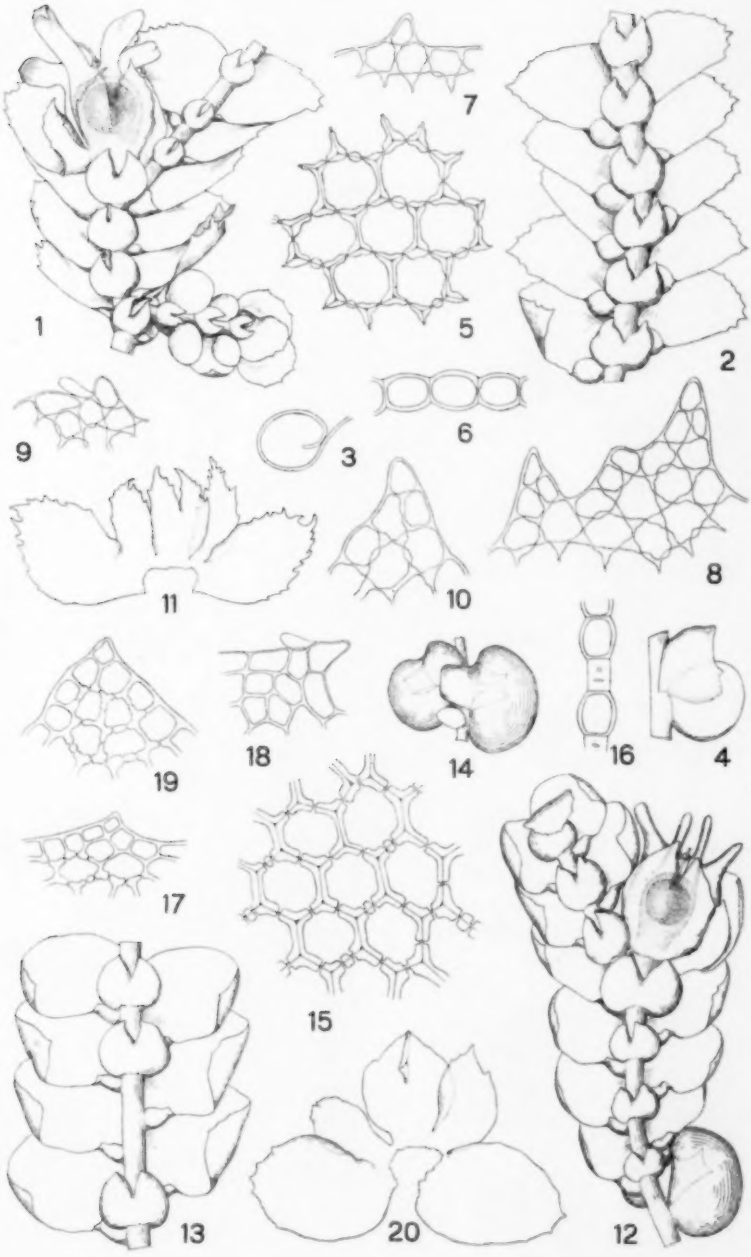
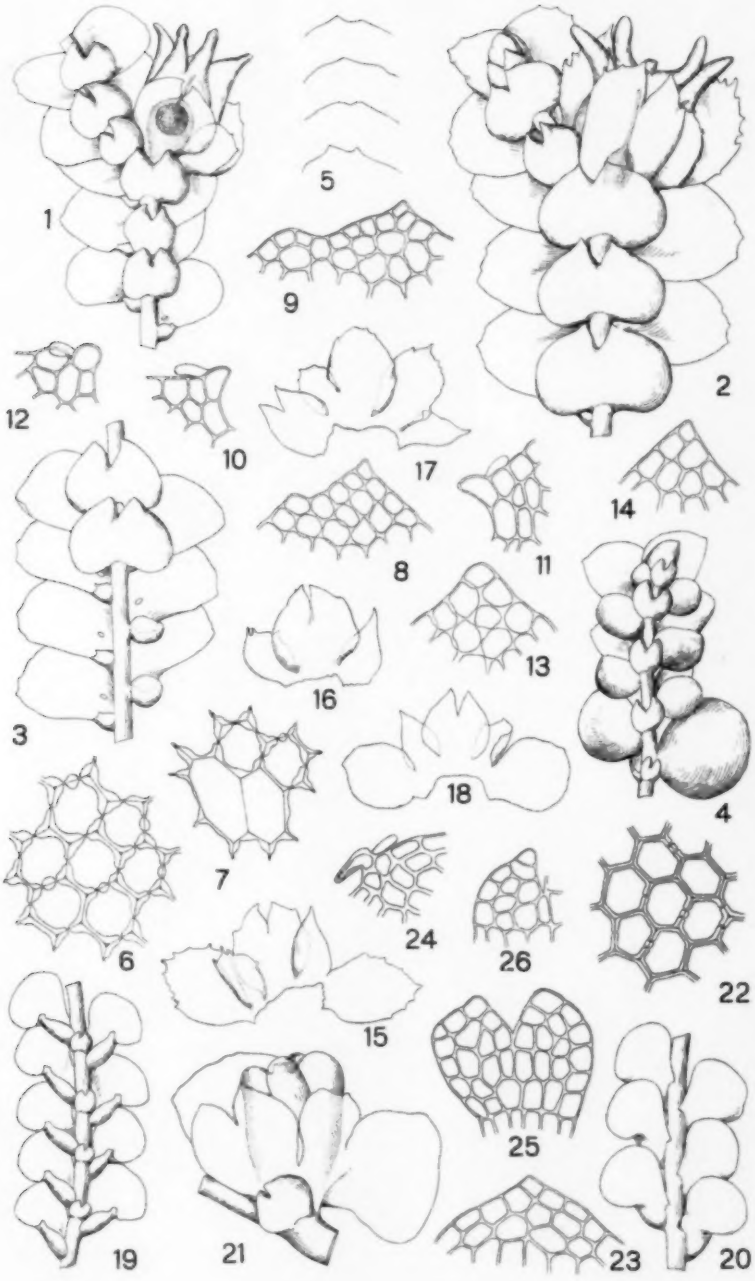


1-11. CERATOLEJEUNEA SPINOSA (Gottsche) Steph.

12-20. CERATOLEJEUNEA VALIDA Evans.



1-18. CERATOLEJEUNEA SCHWANECKEI Steph.

19-26. CERATOLEJEUNEA PATENTISSIMA (Hampe & Gottsche) Evans.

FICUS DAPHNOGENOIDES (HEER) BERRY